Committee on the UBRARY Trade, Actional

# AN ANALYSIS

OF THE

# MOTOR VEHICLE REPAIR TRADE

PREPARED BY

# A NATIONAL COMMITTEE

APPOINTED BY the Vocational Training Branch

THE DEPARTMENT OF LABOUR OTTAWA, CANADA 1957



# AN ANALYSIS

OF THE

# MOTOR VEHICLE REPAIR TRADE

PREPARED BY

## A NATIONAL COMMITTEE

APPOINTED BY

THE DEPARTMENT OF LABOUR
OTTAWA, CANADA
1957

Digitized by the Internet Archive in 2022 with funding from University of Toronto

#### TABLE OF CONTENTS

INTRODUC	CTION
	INTRODUC

#### 2. DIVISIONS OF THE ANALYSIS:

			MISCELLANEOUS PROCEDURES	
BLOCK	2	-	General Shop Practice	Page 1 11 16 18
			POWER TRAINS	
BLOCK	5 6 7 8 9		Clutches	Page 20 30 36 38 40 44
			FUEL AND EXHAUST SYSTEMS	
BLOCK		-	Basic Science Related to Carburetion	Page 46 47 52 57
			ELECTRICAL SYSTEMS	
BLOCK	15 16 17 18 19 20 21 22 23 24 25		Accessories	Page 60 61 64 67 70 74 78 81 84 86
			ENGINES: ACCESSORIES AND COMPONENTS	
BLOCK	26 27		Cooling System	Page 91 94

#### INTRODUCTION

The first National Conference on Apprenticeship in Trades and Industries held at Ottawa in May 1952, recommended that the Federal Government be requested to co-operate with Provincial apprenticeship committees and others concerned in preparing analyses of a number of skilled occupations. In implementing this recommendation, the Vocational Training Branch of the Federal Department of Labour has appointed a number of committees, each of which has compiled an analysis of one trade.

In the case of the Motor Vehicle Repair Trade a committee of four experienced teacher-tradesmen was appointed and the organization meeting was held in Montreal on December 3, 1956. Mr. J. R. Reid, Supervisor of Apprenticeship for the Alberta Department of Labour was named to represent the four Western provinces; Mr. Mervin J. McGuffin, Chief Instructor in the trade in the H.B. Beal Technical School, London, to represent Ontario; Mr. Joseph B. Carignan, Chief instructor in electricity and carburation at the Automobile School in Montreal, represented the Province of Quebec and the fourth member, representing the four Maritime provinces was Mr. Lucide Rioux, instructor in this trade at the Grand Falls School in New Brunswick. The committee was convened by Mr. S. R. Ross, Supervisor of Trade Training for the Federal Department of Labour, Ottawa, Canada.

#### SCOPE OF THE ANALYSIS

While regulations controlling the Motor Vehicle Repair Trade vary somewhat province to province, the elements and techniques are universal and common to all. It was therefore only necessary to delimit the scope of the work to be considered as the basis of this analysis. It was accordingly decided to deal with only those phases of the trade that are commonly considered as comprising the mechanical field.

Having these limitations in mind, the committee has endeavoured to include all operations of the trade that are considered essential in each and every province. In other words, this would be an analysis of such a nature that officials in each province would agree that the operations and knowledge related thereto are complete as the basis of training competent mechanics.

Because of the unvarying nature of the work, the journeyman mechanic applies his techniques in precisely the same manner whether in Newfoundland or in British Columbia. There is little opportunity for the individual to display creativeness because he is not called upon to make or produce any component parts as is the case in some other trades. There is correspondingly less opportunity for personal planning since many of the sequences are outlined in manuals provided by the service divisions of the various motor car manufacturers.

#### INTRODUCTION

Even though this is the case, there is still a most important technique, that of determining the causes of unsatisfactory operation. This calls for keen observation and analysis to determine the procedures necessary to gain desired results. Expert analysis is of course based on a thorough knowledge of the functioning of each component.

In view of the abstract nature of this phase of the trade, the committee urges that emphasis be placed on the 'why' of procedures, so that as the trainee progresses, he will develop a fundamental grasp of the techniques of skilful trouble-shooting, which is so important. This phase of training should be given prominent consideration by all who use this analysis as a guide to instruction and by those who extract courses of study therefrom.

It should be noted that this analysis is not a course of study nor is it intended that items be undertaken in the sequence shown. It is, however, a compilation of essential operations in the mechanical phases of this trade which a fully trained journeyman should be able to perform and also of those items of related knowledge which he should have mastered.

In certain localities, there may be additional techniques in which a journey-man might need to be proficient if he is to render as complete a service as opportunity affords. One such is welding but the committee considers this as an extraneous skill and not an essential part of this trade. It therefore has not been included. This applies as well to Body Repair, Refinishing and Painting as well as to Upholstering. The committee further recommends that the apprentice be introduced to procedures involved in estimating costs of repair work although this is not a prerequisite to journeyman status.

There are certain other elements which will be included automatically in a well planned training program. Such elements will consider personal safety in all the varying situations with which the trainee will be confronted and also will stress necessary precautions in the handling of components to guard against damaging them during disassembling, storing and re-assembling. Orderliness and cleanliness, the care and use of all hand tools, machine tools and other shop equipment should be stressed as a matter of routine. Because of the miscellaneous nature of these items the committee has decided not to indicate them repeatedly throughout the analysis but at the same time wishes to emphasize their importance.

#### PROCEDURE

At the outset the Directors of Apprenticeship agreed to have their provinces represented as indicated above. This ensured that the final compilation would be generally acceptable and would be considered as the national basis of instruction in this trade.

#### INTRODUCTION

Each committee member agreed to compile a main division of the analysis and to refer his work, as it progressed to the others for critical examination. It was felt that this procedure would ensure the validity of each part and guarantee the national aspect of the whole. Each of these main divisions comprises a series of Blocks, each of which is a group of Units. In turn, each Unit is sub-divided into a number of Operations with Related Knowledge clearly indicated.

#### PURPOSES AND USES OF ANALYSIS

By the whole-hearted co-operation of the Directors of Apprenticeship and others this analysis promises to be a standardizing influence in the training of apprentices. This desirable goal will be more nearly realized because the Directors have agreed, on an experimental basis, that the completion examination for all apprentices in Canada will be set by one province for one year and by another province for the next year, and so on. Such a country-wide approach can contribute to uniform training and can facilitate the transfer of credits for apprentices from province to province.

The committee recommends this analysis as a guide to foremen and others who do training on the job; as a basis of programs in industry and for courses of study in vocational schools, trade institutes and other centres; as a yardstick by which the previous experience of newcomers or others may be evaluated.

It is the sincere hope of the committee that this effort will contribute to the nation-wide development of apprenticeship training and will generate a real zeal for uniformly expert craftsmanship in this trade.

The committee desires to express its appreciation to officials of the motor car manufacturing companies for their co-operation in reviewing the work and acting as advisors during its preparation.

## BLOCK 1: Miscellaneous Procedures: General Shop Practice

11		TABLE OF CONTENTS	
UNIT 1:	Hand Tools	and Operations	Page 3
		l: Installing a screw	
		2: Installing a nut or bolt	
		3: Cutting and holding a piece of wire	
		: Driving out a pin	
		5: Cutting a rivet	
	(	6: Measuring length, angle and outside diameter of steel stock	
		7: Measuring inside and outside diameters to thousandths 3: Measuring inside diameters, using gauges	
UNIT 2:	Use of Fast	tenings and Fittings	Page 5
	Onemation 1	la Installing a halt on mut	
		l: Installing a bolt or nut 2: Using a washer	
		3: Replacing a pin or key	
		4: Selecting the proper screw	
		5: Measuring a thread	
		6: Cutting a thread: Internal, external	
		7: Removing a broken stud	
		3: Installing a snap ring	
		9: Installing pipe fittings	
UNIT 3:	Bench Work	and Power Tools	Page 7
	Operation ]	l: Cutting stock with a hacksaw	
		2: Filing to produce a plane surface	
	3	3: Locating a center	
	L	: Heating a soldering copper	
		5: Soldering a joint	
		Sharpening a drill bit	
		7: Sharpening a chisel	
		3: Drilling a hole in metal	
		9: Fitting a bushing	
		O: Inspecting a bearing	
		l: Inspecting an oil seal	
	12	2: Making a gasket	

# BLOCK 1: Miscellaneous Procedures: General Shop Practice

#### TABLE OF CONTENTS

UNIT 4:	Hazardous	Procedures	Page 9
	Operation	1: Lifting a car 2: Operating power equipment 3: Preventing a fire	
UNIT 5:	Auto Body	Care	Page 10
	Operation	1: Cleaning the automobile 2: Adjusting body parts 3: Installing accessories	

BLOCK 1: General Shop Practice UNIT 1: Hand Tools and Operations

OPERATIONS	KNOWLEDGE
l. Installing a screw in wood or metal	(a) Types of screw drivers (b) Sizes of screw drivers (c) Use and care of screw drivers
2. Installing a nut or bolt	<ul> <li>(a) Types of wrenches, including torque wrenches</li> <li>(b) Sizes of wrenches</li> <li>(c) Use and care of wrenches</li> </ul>
3. Cutting and holding a piece of wire	<ul> <li>(a) Common types of pliers e.g. combination and side cutting</li> <li>(b) Special types of pliers e.g. brake spring and battery</li> <li>(c) Use and care of pliers</li> </ul>
4. Driving out a pin, plain or taper	<ul> <li>(a) Types of hammers</li> <li>(b) Sizes of hammers</li> <li>(c) Use and care of hammers</li> <li>(d) Types of punches</li> <li>(e) Sizes of punches</li> <li>(f) Use and care of punches</li> </ul>
5. Cutting a rivet	<ul><li>(a) Types of chisels</li><li>(b) Sizes of chisels</li><li>(c) Use and care of chisels</li></ul>
6. Measuring length, inside and outside diameter of steel stock	<ul> <li>(a) Types of rules, steel squares and protractors</li> <li>(b) Use and care of rules, steel squares and protractors</li> <li>(c) Types of calipers</li> <li>(d) Use and care of calipers</li> <li>(e) Mathematics: addition, subtraction, fractions and angles</li> </ul>

#### AN ANALYSIS OF THE MOTOR VEHCILE REPAIR TRADE

BLOCK 1: General Shop Practice UNIT 1: Hand Tools and Operations

#### **OPERATIONS** KNOWLEDGE 7. Measuring inside and outside (a) Types of micrometers diameter to thousandths (b) Sizes of micrometers (c) Use and care of micrometers (d) Mathematics: Addition, subtraction, fractions and decimal equivalents 8. Measuring inside diameters, using (a) Types of hole gauges (b) Sizes of hole gauges gauges (c) Use and care of hole gauges (d) Related mathematics

BLOCK 1: General Shop Practice UNIT 2: Use of Fastenings and Fittings

OPERATIONS	KNOWLEDŒ
1. Installing a bolt or nut	<ul> <li>(a) Types of thread</li> <li>(b) Number of threads per inch</li> <li>(c) Types of heads e.g. Hexagon</li> <li>(d) Types of nuts e.g. Castellated, Self-locking, Interference, Pal, Clinch</li> </ul>
2. Using various washers	<ul><li>(a) Types of washers</li><li>(b) Sizes of washers</li><li>(c) Uses of washers</li></ul>
3. Replacing a pin or key	<ul><li>(a) Types of pins and keys</li><li>(b) Sizes of pins and keys</li><li>(c) Uses of pins and keys</li></ul>
4. Selecting the proper screw	<ul><li>(a) Types of screws e.g. Wood, Sheetmetal</li><li>(b) Sizes of screws</li><li>(c) Uses of screws</li></ul>
5. Measuring a thread	<ul><li>(a) Measuring with a thread gauge</li><li>(b) Measuring without a thread gauge</li></ul>
6. Cutting a thread: Internal, external	<ul> <li>(a) Types of taps</li> <li>(b) Sizes of taps</li> <li>(c) Use and care of taps</li> <li>(d) Use of tap handles</li> <li>(e) Types of dies</li> <li>(f) Sizes of dies</li> <li>(g) Use and care of dies</li> <li>(h) Use of die handles</li> </ul>
7. Removing a broken stud	(a) Types of extractors (b) Improvised methods

BLOCK 1: General Shop Practice UNIT 2: Use of Fastenings and Fittings

OPERATIONS	KNOWLEDGE
8. Installing a snap ring	<ul><li>(a) Types of snap rings</li><li>(b) Uses of snap rings</li><li>(c) Methods of installation</li></ul>
9. Installing pipe fittings	<ul> <li>(a) Types of pipe fittings, brass, etc.</li> <li>(b) Types of pipe threads</li> <li>(c) Materials used in pipe fittings</li> <li>(d) Corresponding items for hose and hose adapters</li> </ul>

BLOCK 1: General Shop Practice UNIT 3: Bench Work and Power Tools

OPERATIONS	KNOWLEDGE
1. Cutting stock with a hacksaw	<ul> <li>(a) Types of saws e.g.hand and power</li> <li>(b) Sizes of each type</li> <li>(c) Uses of each type</li> <li>(d) Types of blades</li> <li>(e) Sizes of blades</li> <li>(f) Uses of each type</li> <li>(g) Methods of operating saws and cutting speeds</li> </ul>
2. Filing to produce a plane surface	<ul> <li>(a) Types of files</li> <li>(b) Sizes of files</li> <li>(c) Methods of operating files e.g. Posture, positioning work in vise, strokes per minute</li> </ul>
3. Locating a center	<ul><li>(a) Layout methods</li><li>(b) Use of dividers, surface gauges, hermaphrodites</li></ul>
4. Heating a soldering copper	<ul><li>(a) Types of blow torches</li><li>(b) Uses and care of blow torches</li><li>(c) Types of fluid used in blow torches</li></ul>
5. Soldering a joint	<ul> <li>(a) Types and sizes of soldering coppers</li> <li>(b) Care of soldering coppers</li> <li>(c) Tinning soldering coppers</li> <li>(d) Types of cleaners and fluxes</li> <li>(e) Types of solder and their application on different metals</li> </ul>
6. Sharpening a drill bit	<ul> <li>(a) Types of grinders</li> <li>(b) Types of grinding wheels</li> <li>(c) Use and care of grinders</li> <li>(d) Drill bit cutting angles</li> <li>(e) Methods used when sharpening a drill bit</li> </ul>

BLOCK 1: General Shop Practice UNIT 3: Bench Work and Power Tools

OPERATIONS	KNOWLEDGE
7. Sharpening a chisel	<ul><li>(a) Types of metal</li><li>(b) Heat treatment: Tempering, etc.</li><li>(c) Forging</li></ul>
8. Drilling a hole in metal	<ul> <li>(a) Types of drill bits</li> <li>(b) Sizes of drill bits</li> <li>(c) Use and care of drill bits</li> <li>(d) Types of electric drills and drill presses</li> <li>(e) Use and care of drills and drill presses</li> <li>(f) Methods of operation e.g. use of a pilot hole</li> </ul>
9. Fitting a bushing	<ul> <li>(a) Types and sizes of reamers</li> <li>(b) Use and care of reamers</li> <li>(c) Types of hones and honing equipment</li> <li>(d) Use and care of honing equipment</li> <li>(e) Bushing fitting methods e.g. press fit thumb fit</li> </ul>
10. Inspecting a bearing	<ul><li>(a) Types of bearings</li><li>(b) Methods of removal and installation</li><li>(c) Methods of cleaning and inspecting</li></ul>
ll. Inspecting an oil seal	<ul><li>(a) Types of oil seals</li><li>(b) Methods of removal and installation</li><li>(c) Care of oil seals</li></ul>
12. Making a gasket	<ul><li>(a) Types of gasket material</li><li>(b) Methods of making a gasket</li><li>(c) Types and uses of gasket cement</li></ul>

BLOCK 1: General Shop Practice UNIT 4: Hazardous Procedures

OPERATIONS	KNOWLEDGE
1. Lifting a car	<ul> <li>(a) Types of jacks and hoists</li> <li>(b) Use of jacks and hoists</li> <li>(c) Types of safety stands</li> <li>(d) Use of safety stands</li> <li>(e) Safe personal working habits</li> </ul>
2. Operating power equipment	<ul> <li>(a) First-aid methods and injury reports</li> <li>(b) Safe personal working habits while operating hydraulic presses, pullers and centrifugal units</li> <li>(c) Use and importance of safety signs e.g. NEVER adjust or oil while in operation</li> </ul>
3. Preventing and/or extinguishing a fire	<ul> <li>(a) Types of fire extinguishers</li> <li>(b) Uses of fire extinguishers</li> <li>(c) Methods of sending in fire alarms</li> <li>(d) Methods of preventing spontaneous combustion fires and other types</li> <li>(e) Methods of venting areas where volatile fluids are used</li> </ul>

BLOCK 1: General Shop Practice UNIT 5: Auto Body Care

OPERATIONS	KNOWLEDGE
1. Cleaning the automobile	<ul> <li>(a) Use of foam type upholstery cleaners</li> <li>(b) Use of volatile type upholstery cleaners</li> <li>(c) Use of special brushes, sponges, etc.</li> <li>(d) Methods of cleaning: <ol> <li>Convertible tops</li> <li>White wall tires</li> <li>Genuine and imitation leather</li> <li>Outside finishes</li> </ol> </li> <li>(e) Methods of polishing outside finishes</li> </ul>
2. Adjusting body parts	<ul> <li>(a) Methods of checking and adjusting: <ol> <li>Convertible folding tops</li> <li>Door latches and locks</li> <li>Trunk latches and locks</li> <li>Hood latches and locks</li> </ol> </li> <li>(b) Methods of checking and repairing: <ol> <li>Grilles and grille bar rattles</li> <li>Windows and window rail rattles</li> <li>Bodies and body to frame rattles</li> <li>Bumpers and bumper brackets</li> </ol> </li> </ul>
3. Installing accessories	(a) Methods of installing: 1. Radio antennae 2. Front wheel static collectors 3. Hood ground clips and condensers 4. Receivers and back speakers 5. Heaters and air-conditioners

# BLOCK 2: Miscellaneous Procedures: Running Gear

#### TABLE OF CONTENTS

UNIT	1:	Suspension	Page	12
		Operation 1: Positioning and repairing frames and axles 2: Replacing a spring 3: Replacing a shock absorber		
UNIT	2:	Wheels and Tires!	Page	13
		Operation 1: Removing a wheel 2: Balancing a wheel-assembly 3: Replacing a wheel 4: Repairing a tire		
UNIT	3:	Steering Alignment	Page	14
		Operation 1: Centering a car on an aligner 2: Determining points of wear 3: Adjusting camber 4: Adjusting caster 5: Adjusting toe-in 6: Checking king-pin inclination 7: Checking turning radius 8: Adjusting the steering gear		
UNIT	4:	Power Steering	Page	15
		Operation 1: Aligning power steering 2: Servicing the power unit		

BLOCK 2: Running Gear

UNIT 1: Suspension

OPERATIONS	KNOWLEDGE	
1. Positioning and repairing frames and axles	<ul> <li>(a) Types and construction of frames</li> <li>(b) Materials used in frames</li> <li>(c) The effect broken or distorted frames have on steering</li> <li>(d) Methods of aligning bent frames and positioning rear axles</li> <li>(e) Types and components of front wheel suspension</li> <li>(f) Methods of straightening and repairing front and rear axles</li> </ul>	
2. Replacing a spring	<ul> <li>(a) Types and characteristics of coil and leaf springs</li> <li>(b) Types of torsion bar suspension</li> <li>(c) Types of shackles and spring seats</li> <li>(d) Reasons for and results of spring sag</li> </ul>	
3. Replacing a shock absorber	<ul> <li>(a) Types of shock absorbers</li> <li>(b) Sizes and characteristics of shock absorbers</li> <li>(c) Methods of servicing shock absorbers and stabilizer bars</li> <li>(d) Types of shock absorber fluids</li> </ul>	

BLOCK 2: Running Gear UNIT 2: Wheels and Tires

OPERATIONS	KNOWLEDGE
1: Removing a wheel	(a) Types of wheels, rims and hubs (b) Types of wheel fasteners
2: Balancing a wheel-assembly	<ul> <li>(a) Methods of cleaning and inflating tires</li> <li>(b) Types of wheel balancers</li> <li>(c) Methods of mounting and operating wheel balancers</li> <li>(d) Methods of correcting static and dynamic unbalance</li> <li>(e) Types of wheel weights</li> </ul>
3; Replacing a wheel	<ul> <li>(a) Methods of wheel positioning</li> <li>(b) Methods of fastening, and setting tension</li> <li>(c) Methods of replacing hub caps, special wheel rims, etc.</li> </ul>
4: Repairing a tire	<ul> <li>(a) Types, sizes and construction of tires and tubes</li> <li>(b) Methods of removing and inspecting tires and tubes</li> <li>(c) Methods of repairing tires, and tubes</li> <li>(d) Effects on tires of incorrect air pressure</li> <li>(e) Effects on tires of incorrect steering angles</li> </ul>

BLOCK 2: Running Gear

UNIT 3: Steering Alignment

OPERATIONS	KNOWLEDGE
1: Centering a car on an aligner	<ul><li>(a) Types and construction of steering aligners</li><li>(b) Methods of installing checking heads, jacks, lights etc.</li></ul>
2: Determining points of wear	(a) Methods of checking and correcting:  1. Wheel bearing wear  2. Wheel run out  3. Steering linkage  4. Tire inflation  5. Tracking and shock absorbers
3. Adjusting camber	<ul><li>(a) Meaning of camber</li><li>(b) Purpose of camber</li><li>(c) Method of measuring and correcting camber</li></ul>
4: Adjusting Caster	<ul><li>(a) Meaning of caster</li><li>(b) Purpose of caster</li><li>(c) Methods of measuring and correcting caster</li></ul>
5: Adjusting toe-in	<ul><li>(a) Meaning of toe-in</li><li>(b) Purpose of toe-in</li><li>(c) Method of measuring and adjusting toe-in</li></ul>
6: Checking king-pin inclination	<ul> <li>(a) Meaning of king-pin inclination</li> <li>(b) Purpose of king-pin inclination</li> <li>(c) Methods of adjusting e.g. bending straight front axles</li> </ul>
7: Checking turning radius	<ul> <li>(a) Meaning of turning radius</li> <li>(b) Purpose of turning radius</li> <li>(c) Methods of measuring and correcting turning radius angles</li> </ul>
8: Adjusting the steering gear	<ul> <li>(a) Purpose of steering box adjustments</li> <li>(b) Methods used in making steering box adjustments</li> <li>(c) Methods of adjusting steering linkage</li> </ul>

BLOCK 2: Running Gear

UNIT 4: Power Steering

OPERATIONS	KNOWLEDGE	
1: Aligning power steering	(a) Items in Block 2 Unit 3	
2: Servicing the power unit	<ul> <li>(a) Pascal's principle</li> <li>(b) Types and operation of power steering</li> <li>(c) Types of hydraulic fluids</li> <li>(d) Methods of making mechanical adjustments</li> <li>(e) Methods of servicing the pump, control valves, lines and steering gear</li> <li>(f) Methods of bleeding and trouble shooting the system</li> </ul>	

#### BLOCK 3: Miscellaneous Procedures: Brakes - Hydraulic, Vacuum, Air

#### Table of Contents

#### Block Three - One Unit

Operation	Pa	age
	2: Replacing Brake Drums, Brake Shoes and Linings . 1 3: Adjusting Brakes	L7 L7 L7
	ding basic science and information that will be included tional work	7

BLOCK 3: Brakes

UNIT 1: Hydraulic, Vacuum, Air

OPERATIONS	KNOWLEDGE	
1: Repairing cylinders	<ul> <li>(a) Importance of cleanliness</li> <li>(b) Methods used in reconditioning wheel and master cylinder</li> <li>(c) Methods used in brake-line service</li> </ul>	
2. Replacing brake drums, shoes and linings	(a) Methods used in reconditioning and replacing: drums, linings, shoes, brake leverage and linkage	
3. Adjusting brakes	<ul> <li>(a) Methods of flushing brake systems</li> <li>(b) Methods of filling and bleeding.     Type of fluid</li> <li>(c) Methods of making major and minor adjustments</li> <li>(d) Methods of relining and adjusting parking brakes</li> <li>(e) Methods of freeing and lubricating brake parts</li> </ul>	
4. Repairing power brakes	<ul> <li>(a) Purpose, types construction and operation</li> <li>(b) Methods of cleaning, repairing and adjusting</li> <li>(c) Types of pumps and operating pressures</li> <li>(d) Methods of cleaning, repairing and adjusting</li> </ul>	

NOTE: Certain components of the modern motor car are designed around and function because of certain basic scientific principles. It is intended that these principles and general information should be dealt with in a formal class-room lecture series and not necessarily be dependent upon and tied to manipulative shop procedures.

Scientific topics and items of general knowledge such as the following should be covered: Pascal's principles, pressure and vacuum, classes and principle of levers, brake pedals and linkage, parking brakes, friction and materials to resist same, study of wheel assemblies, brake cylinders (vacuum, air, fluid) and miscellaneous accessories.

#### BLOCK 4: Miscellaneous Procedures: Lubrication - Lubricants and Lubricating

#### Table of Contents

#### Block Four - One Unit

Operation			Page
	1:	Pressure testing the engine lubricating system	19
		Lubricating the vehicle	19

BLOCK 4: Lubrication

UNIT 1: Lubricants and Lubricating

OPERATIONS	KNOWLEDGE
1. Pressure testing the engine lubricating system	<ul> <li>(a) Types and operation of oiling systems</li> <li>(b) Types and use of pressure testers</li> <li>(c) Types and purpose of oil filters</li> <li>(d) Methods of flushing and servicing the system</li> <li>(e) Types and operation of oil pressure regulators</li> </ul>
2. Lubricating the vehicle	<ul> <li>(a) Types and use of manufacturers' lubrication charts</li> <li>(b) Methods of application and types of lubricants used in the following: <ol> <li>Steering gear units and steering pivot points</li> <li>Conventional and automatic transmissions</li> <li>Universal joints, differentials and rear axle bearings</li> <li>Front wheel bearings</li> <li>Engine crankcase breathers and air cleaners</li> <li>Starters, generators and distributors</li> <li>Clutch and brake linkage</li> <li>Speedometer and brake cables</li> </ol> </li></ul>
3. Lubricating body parts	<ul> <li>(a) Methods of cleaning and lubricating:</li> <li>1. Door, deck and hood locks</li> <li>2. Door hinges and striker plates</li> <li>3. Door check, link, shoes and rollers</li> <li>4. Hood latches</li> </ul>

NOTE: Items of related information of general interest in connection with the above operations are as follows: methods used in refining crude oil; types, viscosity and service ratings of oils; types of additives and detergents; types, grades and service ratings of greases.

#### BLOCK 5: Power Trains - Clutches

#### TABLE OF CONTENTS

UNIT 1:	Removing and	Installing Clutch Assembly	Page 22
	Operation 1: 2:	Removing Clutch Assembly Installing Clutch Assembly	
UNIT 2:	Clutch Discs	••••••	Page 23
	2:	Checking Facings for Wear Checking Discs for Defects Testing Disc Alignment Refacing Clutch Discs	
UNIT 3:	Flywheel		Page 24
	2:	Inspecting for Ridges, Scores or Cracks Testing for Warpage or Misalignment Removing and Installing Clutch Shaft Pilot Bearing Lubricating Pilot Bearing	
UNIT 4:	Pressure Plat	te and Cover	Page 25
	2: 3: 4: 5: 6:	Burns Disassembling Pressure Plate and Cover Testing Pressure Plate Springs Inspecting and Replacing Release Lever Bearings	
UNIT 5:	Release Bear	ings	Page 26
	2:	Cleaning Release Bearings Inspecting Release Bearings Replacing Release Bearings Inspecting and Replacing Release Bearing Hubs Lubricating Release Bearings	

#### BLOCK 5: Power Trains - Clutches

#### TABLE OF CONTENTS

UNIT 6:		Clutch Linkage		Page 27
		2:	Inspecting Clutch Linkage for Wear or Binding Removing and Replacing Clutch Linkage Adjusting Clutch Linkage	
UNIT	7:	Fluid Coupling	S	Page 28
		2:	Removing Fluid Couplings Draining and Refilling Fluid Couplings Replacing Shaft Seals Installing Fluid Couplings	
UNIT	8:	Torque Convert	ers	Page 29
		2:	Removing Torque Converters Draining Torque Converters Installing Torque Converters	

UNIT 1: Removing and Installing Clutch Assembly

OPERATIONS	KNOWLEDGE
1. Removing clutch assembly	<ul> <li>(a) Purpose of clutch</li> <li>(b) Clutch nomenclature</li> <li>(c) Clutch construction</li> <li>(d) Clutch operation</li> <li>(e) Types of clutches (coil spring, diaphragm, crown pressure)</li> </ul>
2. Installing clutch assembly	<ul> <li>(a) Proper tightening sequence</li> <li>(b) Purpose of clutch balancing</li> <li>(c) Methods of clutch balancing</li> <li>(d) Testing for proper clutch operation</li> <li>(e) Alignment arbors: Types and purpose</li> </ul>

UNIT 2: Clutch Discs

OPERATIONS	KNOWLEDGE
1. Checking facings for wear	<ul> <li>(a) Friction and its properties</li> <li>(b) Clutch facing materials</li> <li>(c) Dry type clutch discs</li> <li>(d) Wet type clutch discs</li> <li>(e) Single and multiple disc types</li> <li>(f) Causes of normal and abnormal facing wear</li> </ul>
2. Checking discs for defects	<ul><li>(a) Vibration dampening devices</li><li>(b) Causes of chattering, grabbing, slipping or dragging</li><li>(c) Purpose of disc waves</li></ul>
3. Testing disc alignment	<ul><li>(a) Methods of setting up and using dial indicator</li><li>(b) Permissible limits or tolerances</li></ul>
4. Refacing clutch discs	<ul><li>(a) Method of removing clutch facing rivets</li><li>(b) Method of riveting facings to clutch discs</li></ul>

UNIT 3: Flywheel

OPERATIONS	KNOWLEDGE
1. Inspecting for ridges, scores or cracks	(a) Causes of damage to flywheel: Accidents, slippage, worn facings, dirt, etc.
2. Testing for misalignment	(a) Permissible limits (b) Use of dial indicator
3. Removing and installing clutch shaft pilot bearing	<ul> <li>(a) Types of pilot bearings</li> <li>(b) Use of special pullers</li> <li>(c) Purpose of pilot bearing</li> <li>(d) Methods of determining bearing condition</li> <li>(e) Use of special drivers</li> </ul>
4. Lubricating pilot bearing	<ul><li>(a) Type of lubricant to use</li><li>(b) How to clean and lubricate pilot bearings</li></ul>

UNIT 4: Pressure Plate and Cover

OPERATIONS	KNOWLEDGE
1. Inspecting assembly for wear	<ul> <li>(a) Purpose of pressure plate</li> <li>(b) Types of pressure plate units: Coilspring diaphragm, crown pressure spring, semi-centrifugal</li> <li>(c) Construction of pressure plates - Metals used</li> </ul>
2. Inspecting pressure plate for scores, warpage or burns	<ul><li>(a) Causes of scoring, warping or burning (heat cracks)</li><li>(b) Use of straight edge</li><li>(c) Permissible limits</li></ul>
3. Disassembling pressure plate and cover	(a) Methods of using special fixtures
4. Testing pressure plate springs	<ul> <li>(a) Methods and equipment used</li> <li>(b) Importance of equalized spring pressures</li> <li>(c) Identification of different colors of springs</li> </ul>
5. Inspecting and replacing release lever bearings	<ul> <li>(a) Types of bearings: Needle, ball, roller, solid</li> <li>(b) Sizes and ratings of bearings</li> <li>(c) Methods of determining serviceability of bearings</li> </ul>
6. Assembling pressure plate and cover	(a) Lubrication of pivot points
7. Adjusting release levers	<ul> <li>(a) Importance of accurate adjustments</li> <li>(b) Use of special fixtures</li> <li>(c) Levers, fulcrums, pivots</li> <li>(d) Purpose and operation of semicentrifugal release levers</li> <li>(e) Manufacturers' specifications</li> </ul>

UNIT 5: Release Bearings

OPERATIONS	KNOWLEDGE
1. Cleaning release bearings	<ul> <li>(a) Types of release bearings</li> <li>(b) Proper use of cleaning solvents</li> <li>(c) Purpose of release bearings</li> <li>(d) Operation of release bearings</li> <li>(e) Thrust bearing principles</li> </ul>
2. Inspecting release bearings	(a) How to determine serviceability of release bearings (b) Causes of release bearing failures
3. Replacing release bearings	(a) Use of arbor press (b) Use of hydraulic press
4. Inspecting and replacing release bearing hubs	<ul><li>(a) Methods of mounting release bearing hubs to forks</li><li>(b) Use of micrometer to check OD against specification</li></ul>
5. Lubricating release bearings	<ul> <li>(a) Types of bearing lubricants</li> <li>(b) Methods of lubricating release bearings</li> <li>(c) Factory or pre-lubricated release bearings</li> </ul>

UNIT 6: Clutch Linkage

OPERATIONS	KNOWLEDGE
1. Inspecting clutch linkage for wear or binding	<ul> <li>(a) Cause and possible results of clutch linkage wear</li> <li>(b) Cause and possible results of binding linkage</li> <li>(c) Determining serviceability of clutch linkage</li> <li>(d) Operation of over-center springs</li> </ul>
2. Removing and replacing clutch linkage	<ul><li>(a) Methods used to lock or retain clutch linkage</li><li>(b) Lubrication of clutch linkage</li></ul>
3. Adjusting clutch linkage	<ul><li>(a) Clutch pedal clearances</li><li>(b) Clutch pedal free travel</li><li>(c) Importance of correct adjustments</li></ul>

UNIT 7: Fluid Couplings

OPERATIONS	KNOWLEDGE
1. Removing fluid couplings	<ul> <li>(a) Operating principles</li> <li>(b) Fluid coupling components</li> <li>(c) Advantages of fluid couplings</li> <li>(d) Disadvantages of fluid couplings</li> <li>(e) Importance of noting balance marks</li> <li>(f) Causes of heat generation</li> <li>(g) Foaming and its causes</li> </ul>
2. Draining and refilling fluid couplings	<ul> <li>(a) Type of oil used</li> <li>(b) Method of checking oil level</li> <li>(c) Methods used to prevent overfilling</li> <li>(d) Causes and possible results of oil leakage</li> </ul>
3. Replacing shaft seals	<ul> <li>(a) Types of oil seals</li> <li>(b) Oil seal materials and construction</li> <li>(c) Special tools required to remove and install oil seals</li> <li>(d) Special precautions involved in replacing fluid coupling oil seals</li> </ul>
4. Installing Fluid Couplings	(a) Use of alignment arbors (b) Precautions

BLOCK 5: Clutches

UNIT 8: Torque Converters

OPERATIONS	KNOWLEDGE
1. Removing torque converters	<ul> <li>(a) Torque converter principles and ratios</li> <li>(b) Torque converter components</li> <li>(c) Advantages of torque converters</li> <li>(d) Types of torque converters</li> <li>(e) Meaning of torque, centrifugal force, vortex</li> <li>(f) Methods used to direct fluid flow</li> <li>(g) Purpose and operation of over-running clutch</li> <li>(h) Use of alignment arbors</li> </ul>
2. Draining torque converters	(a) Torque converter fluids (b) Methods used to cool same
3. Installing torque converters	<ul><li>(a) Precautions</li><li>(b) Methods of checking for proper operation</li></ul>

## BLOCK 6: Power Trains - Transmissions

## TABLE OF CONTENTS

UNIT	1:	Removing a	and I	Installing Transmission	Page	31
		Operation	2:	Removing a Transmission Checking Clutch Housing for Alignment and Bore Run-or Installing a Transmission	ut	
UNIT	2:	Disassembl	ling	, Inspecting and Assembling a Transmission	Page	32
		Operation	2: 3: 4:	Disassembling a Three-speed Transmission Disassembling and Inspecting Synchromesh Unit Inspecting Transmission Components for Wear or Damage Assembling Three-speed Transmission Adjusting Shifting Linkage	e	
UNIT	3:	Overdrive	8 .	• • • • • • • • • • • • • • • • • • • •	Page	33
		Operation		Removing and Disassembling Overdrive Assembling and Installing Overdrive		
UNIT	4:	Automatic	Tra	nsmissions	Page	34
		Operation	2: 3: 4:	Removing Automatic Transmission Disassembling and Inspecting Automatic Transmission Assembling Automatic Transmission Installing Automatic Transmission Making External Adjustments		

UNIT 1: Removing and Installing
Transmission

# **OPERATIONS** KNOWLEDGE 1. Removing a transmission (a) Purpose of transmission (b) Draining lubricant (c) Removal of members etc. to permit accessibility to transmission (d) Necessity of using pilot studs (e) Use of engine and car-support fixtures 2. Checking clutch housing alignment (a) Use of special arbor (b) Use of service manuals and bore run-out (c) Use of dial indicator (a) Selection of proper lubricant 3. Installing a transmission (b) Methods of refilling transmission (c) Possible results of insufficient or improper lubricant (d) Methods of checking transmission for proper operation

UNIT 2: Disassembling, Inspecting and Assembling Transmission

OPERATIONS	KNOWLEDGE
1. Disassembling three-speed transmission	<ul> <li>(a) Principles of gearing</li> <li>(b) Gear rations (mechanical advantages)</li> <li>(c) Types of gears: Spur, bevel, helical</li> <li>(d) Types of transmissions: 3 and 4 speed, synchromesh, constant mesh</li> <li>(e) Methods of tracing power flow</li> <li>(f) Removal of welch plugs</li> <li>(g) Purpose and operation of detent balls, shifter rails, forks, interlocks</li> <li>(h) Methods of locking counter shaft, idler shaft</li> </ul>
2. Disassembling and inspecting synchromesh unit	<ul> <li>(a) Purpose of synchromesh</li> <li>(b) Synchromesh operation</li> <li>(c) Methods of removing and installing snap-rings</li> <li>(d) Special tools and bench-stands</li> </ul>
3. Inspecting transmission components for wear or damage	<ul> <li>(a) Causes of wear or damage</li> <li>(b) Removal and installation of oil seals</li> <li>(c) Gasket materials</li> <li>(d) Mainshaft end-play</li> <li>(e) Causes of gear noises</li> </ul>
4. Assembling three-speed transmission	<ul> <li>(a) Gear alignment and tooth contact</li> <li>(b) Permissible counter-shaft end-play</li> <li>(c) Proper location of counter-shaft thrust washers</li> <li>(d) Installation of welch plugs</li> <li>(e) Reasons for using new gaskets and snap rings</li> </ul>
5. Adjusting shifting linkage	<ul> <li>(a) Importance of proper adjustments</li> <li>(b) Shifting linkages (rods, cables)</li> <li>(c) Shifting assists (vacuum, electric)</li> <li>(d) Proper lubrication</li> </ul>

UNIT 3: Overdrives

OPERATIONS	KNOWLEDGE
1. Removing and disassembling overdrive	<ul> <li>(a) Principles of overdrive</li> <li>(b) Operation of overdrive</li> <li>(c) Advantages of overdrive</li> <li>(d) Speeds at which overdrive cuts in or out</li> <li>(e) Overdrive lock-out mechanism</li> <li>(f) Overdrive step-down mechanism</li> <li>(g) Tracing flow of power</li> <li>(h) Causes of overdrive failure to engage or dis-engage</li> </ul>
2. Assembling and installing overdrive	<ul> <li>(a) Methods of tracing and testing electrical circuits</li> <li>(b) Methods of checking and adjusting control linkages</li> <li>(c) Purpose and operation of relays and solenoids</li> <li>(d) Purpose and operation of governors</li> <li>(e) Methods of cleaning and adjusting solenoid contact points</li> <li>(f) Methods of adjusting solenoid throttle switch and kick-down switch</li> <li>(g) Overdrive lubrication</li> <li>(h) Methods of testing overdrive for proper operation</li> </ul>

UNIT 4: Automatic Transmissions BLOCK 6: Transmissions **OPERATIONS** KNOWLEDGE (a) Methods of draining automatic trans-1. Removing automatic transmissions missions before removal (b) Purpose and advantages of automatic transmissions (c) Purpose and methods of cooling automatic transmission fluid (d) Types of automatic transmissions (a) Use of special tools and bench stands 2. Disassembling and inspecting automatic (b) Names of components transmissions (c) Types of automatic transmission oil pumps (d) Methods of checking oil pumps and

- (d) Methods of checking oil pumps and pressure relief valves(e) Operation and construction of automatic
- (e) Operation and construction of automatic transmission clutches and brake bands
- (f) Methods of tracing internal oil circuits
- (g) Operation of servoes
- (h) Tracing flow of power at various speeds
- (i) Determining serviceability of various components
- (j) Causes of automatic transmission failure
- 3. Assembling automatic transmissions
- (a) Methods and specifications for internal adjustments
- (b) Special tools and gauges required
- (c) Lubrication
- (d) Methods of testing circuits, e.g. compressed air

UNIT 4: Automatic Transmissions

# OPERATIONS KNOWLEDGE 4. Installing automatic transmissions (a) Use of aligning arbors (b) Methods of fastening automatic transmissions and fluid couplings or torque converters to flywheel 5. Making external adjustments (a) Road testing procedures (b) Methods of adjusting controls

NOTE: The apprentice is required to master only general information and basic principles common to all automatic transmissions. The analysis indicates the limits of such instruction in anticipation that he will pursue further study and possibly specialized training in this field. Specific data may be secured from specifications of the various manufacturers.

## BLOCK 7: Power Trains - Universal Joints

#### TABLE OF CONTENTS

## Block Seven - One Unit

Operation			Page
	1:	Removing and Disassembling Ball and Trunnion Universal Joints	37
	2:	Assembling and Installing Ball and Trunnion Universal Joints	
	3:	Removing and Disassembling Two-yoke and Cross Universal Joints	
	4:	Assembling and Installing Two-yoke and Cross Universal Joints	,

BLOCK 7: Universal Joints

UNIT 1: Servicing Universal Joints

## **OPERATIONS** KNOWLEDGE 1. Removing and disassembling ball and (a) Purpose of universal joints trunnion universal joints (b) Operation of universal joints (c) Types of universal joints (d) Purpose of univeral joint boots (e) Use of hydraulic and arbor presses 2. Assembling and installing ball and (a) Methods of determining serviceability trunnion universal joints of parts (b) Permissible off-center limits of trunnion pin (c) Method of checking position of trunnion pin in shaft 3. Removing and disassembling two-yoke (a) Methods of removing lock-rings (b) Methods of cleaning and inspecting and cross universal joints universal joint needle bearings (a) Importance of using new locking 4. Assembling and installing two-yoke devices and cross universal joints (b) Methods of lubrication (c) Types of lubricants (d) Causes of universal joint failure (e) Purpose of arrows on some universal joints

## BLOCK 8: Power Trains - Propeller Shafts

## TABLE OF CONTENTS

## Block Eight - One Unit

Operation			Page
•	1:	Removing, Checking and Installing Torque-tube and Shaft	39
	2:	Removing, Checking and Installing Hotchkiss Drive Propeller Shafts	39
	3:	Lubricating Ball and Slip Joints	39

BLOCK 8: Propeller Shaft

UNIT 1: Servicing Propeller Shafts

# **OPERATIONS** KNOWLEDGE (a) Function of propeller shaft 1. Removing, checking and installing (b) Types of drives: Torque-tube, Hotchkiss torque-tube and shaft (c) Purpose of truss rods (d) Meaning of rear-end torque (e) Purpose and operation of ball joints (f) Purpose and operation of slip joints (g) Method of adjusting ball joints (h) Methods of checking propeller shaft for balance and alignment (i) Reasons for using hollow drive shaft (a) Advantages of Hotchkiss drive 2. Removing, checking and installing (b) Meaning of forward thrust Hotchkiss drive propeller shaft (c) How drive is transmitted by torquetube and Hotchkiss drives (a) Use of proper lubricants(b) Methods of lubrication(c) Methods of adjusting ball joints 3. Lubricating ball and slip joints

## BLOCK 9: Power Trains - Differentials

## TABLE OF CONTENTS

UNIT 1:	Removing and	Replacing Rear Axle Assembly	Page 41
		Removing Rear Axle Assembly Installing and Aligning Rear Axle Assembly	
UNIT 2:	Removing and	Installing Differential Carrier Assembly	Page 42
		Removing Differential Carrier Assembly Installing and Lubricating Differential Carrier Assembly	
UNIT 3:	Disassembling	, Checking and Reassembling Differential	Page 43
	2: 3: 4: 5:	Disassembling Differential Removing and Installing Differential Ring Gear Checking Ring Gear Run-out Removing and Installing Differential Side Bearings Assembling and Adjusting Differential Removing and Installing Drive Pinion, Bearings and Oil Seals	

BLOCK 9: Differentials

UNIT 1: Removing and Replacing Rear Axle Asembly

# **OPERATIONS** KNOWLEDGE 1. Removing rear axle assembly (a) Methods used to support car (b) Types of rear suspensions (c) Methods of checking rear axle housing alignment (d) Types of rear axle housings (e) Function of torque arms (f) Two speed rear axles 2. Installing and aligning rear (a) Methods of checking and aligning axle assembly rear axle assembly (b) Meaning of axle ratio (c) Methods of determining axle ratio

#### AN ANALYSIS OF THE MOTOR VEHICLE REPAIR TRADE

UNIT 2: Removing and Installing BLOCK 9: Differentials Differential Carrier Assembly OPERATIONS KNOWLEDGE (a) Methods of draining lubricant 1. Removing differential carrier assembly (b) Methods of flushing differential assembly (c) Carrier assembly components (a) Use of extreme pressure lubricants 2. Installing and lubricating differential carrier assembly (b) Use of hypoid gear lubricants (c) Importance of not mixing different brands of hypoid gear lubricants (d) Meaning of active and inactive gear lubricants (e) Method of interpreting viscosity ratings and lubrication charts

BLOCK 9: Differentials

UNIT 3: Disassembling, Checking and Reassembling Differential

OPERATIONS	KNOWLEDGE
1. Disassembling differential	<ul> <li>(a) Purpose of differential</li> <li>(b) Operation of differential</li> <li>(c) Differential components</li> <li>(d) Types of differential ring-gears and</li> </ul>
	pinions: Spur, bevel, hypoid and worm  (e) Differential gear ratios  (f) Advantages of hypoid gearing  (g) Tracing the power flow  (h) Meaning of torque and foot-pounds
2. Removing and installing differential ring-gear	<ul> <li>(a) Method of removing rivets</li> <li>(b) Methods of re-attaching ring-gear to differential case</li> <li>(c) Use of special bench fixtures</li> </ul>
3. Checking ring-gear run-out	(a) Use of dial indicator
4. Removing and installing differential side bearings	<ul><li>(a) Use of special pullers and drivers</li><li>(b) Conditions affecting serviceability of bearings</li></ul>
5. Assembling and adjusting differential	<ul> <li>(a) Method of checking backlash</li> <li>(b) Purpose and method of adjusting backlash</li> <li>(c) Purpose and method of checking and adjusting tooth contact</li> <li>(d) Method of pre-loading bearings</li> <li>(e) Purpose of pre-loading bearings</li> <li>(f) Causes of gear noises</li> <li>(g) Adjustment crown gear thrust pad</li> </ul>
6. Removing and installing drive pinion, bearings and oil seals	<ul><li>(a) Method of removing oil seals</li><li>(b) Method of installing oil seals</li><li>(c) Methods of adjusting drive pinion bearings</li></ul>

## BLOCK 10: Power Trains - Rear Axles

## TABLE OF CONTENTS

## Block Ten - One Unit

Operation		Page
1:	Removing, Checking and Installing Semi- floating Rear Axle	45
2:	Removing, Checking and Installing Three- quarter Floating Rear Axle	45
3:	Removing, Checking and Installing Full-floating Rear Axle	45
4:	Removing and Installing Rear Axle Bearings and Oil Seals	45
5:	Removing and Replacing Broken Rear	45

BLOCK 10: Rear Axles

UNIT 1: Removing, Checking and Installing Rear Axles

OPERATIONS	KNOWLEDGE
1. Removing, checking and installing semi-floating rear axle	<ul> <li>(a) Differences between live and dead axles</li> <li>(b) Types of live rear axles: Semificating, three-quarter floating, full-floating</li> <li>(c) Use of special axle pullers</li> <li>(d) Methods of checking and adjusting rear axle end-play</li> <li>(e) Methods of checking rear axle shaft alignment</li> <li>(f) Methods of adjusting rear axle bearings</li> <li>(g) Forces acting on axle</li> </ul>
2. Removing, checking and installing three-quarter floating rear axle	<ul><li>(a) Types of bearings used on different types of rear axles</li><li>(b) Forces acting on axle</li></ul>
3. Removing, checking and installing full-floating rear axle	<ul><li>(a) Methods of retaining and adjusting axle bearings</li><li>(b) Forces acting on axle</li></ul>
4. Removing and installing rear axle bearings and oil seals	<ul> <li>(a) Use of special axle bearing pullers</li> <li>(b) Pre-lubrication of oil seals</li> <li>(c) Use of special bearing and oil seal drivers</li> <li>(d) Methods of checking bearing condition</li> <li>(e) Types of oil seals and oil deflectors</li> </ul>
5. Removing and replacing broken rear axle	<ul> <li>(a) Possible causes of rear axle breakage</li> <li>(b) Methods of remvoal and replacing axle flange bolts</li> <li>(c) Importance of eliminating excessive</li> </ul>

backlash

Block 11: Fuel and Exhaust Systems - Basic Science Related to Carburetion

#### TABLE OF CONTENTS

#### Block Eleven - One Unit

The topics indicated below are items of basic knowledge and information which should be familiar to journeymen and therefore should be included in the training of apprentices.

- 1. Function and types of Carburetor: Up-draft and down-draft.
- 2. Air: Composition, density, atmospheric pressure; affect of pressure on vapor point of a liquid; vacuum as measured in inches of mercury.
- 3. Products of Grude Oil: diesel oil, fuel oil, gasoline and liquified petroleum.
- 4. Gasoline: Nature and density; cracking process, molecules, light fractions, heavy fractions, explosive mixtures rich, lean, economy and power mixture; anti-knock, tetraethyl lead, octane number; vaporization and atomization.
- 5. By-products of Combustion: Carbon dioxide, carbon monoxide, water vapor, sulphur.
- 6. Blueprint and Diagram Reading (Manuals, sectional drawings, etc.) to determine construction, adjustments, etc.
- 7. Fuel injection: Diesel fuel.

# Block 12: Fuel and Exhaust Systems - Carburetors

## TABLE OF CONTENTS

Unit 1:	Single Barrel	Carburetor Page	48
	Operation 1: 2: 3: 4: 5: 6: 7: 8: 9: 10:	Disassembling the Carburetor Checking the Idling Circuit Checking the Main Circuit Checking the Power Circuit Checking the Accelerating Circuit Checking and Adjusting the Float Level Checking and Adjusting the Automatic Choke Checking the Auxiliary Components Repairing or Replacing Defective Parts Trouble Finding	
Unit 2:	Dual and Quad	ruple Barrel Carburetor Page	53
	Operation 1: 2: 3: 4: 5: 6: 7: 8: 9:	Disassembling the Carburetor Checking Idling Circuits Checking Main Circuits Checking Power Circuits Checking Accelerating Circuits Checking and Adjusting Float Level Checking and Adjusting Automatic Choke Checking Auxiliary Components Repairing or Replacing Defective Parts Trouble Finding	

UNIT 1: Single Barrel Carburetor

(d) Function of the anti-percolator. Adjustments

(e) Metering pin setting gauge

## KNOWLEDGE OPERATIONS 1. Disassembling the (a) Proper tools to use. Specifications carburetor (b) Cleaning solutions (c) Sub-assembly parts: air horn, main body, throttle body, linkage (d) Properties of metals: die castings, white metal (e) Construction and function of individual parts: choke valve, air breather, throttle valve, concentric float chamber, float, needle valve and seat; Mixing chamber, venturi, discharge nozzle and jets, metering plugs, metering pins and air bleeds (a) Purpose of the idling circuits 2. Checking the idling & fast (b) Functioning of the idling speed circuits: idling circuits and compo-Path of the gasoline, path of the air nent parts Relation of the discharge ports to the throttle valve Idling mixture screw, idling speed screw Methods of metering gasoline and air to the circuits Purpose of the fast idling circuit Relation of the fast idling discharge port to the throttle valve position (c) Position of the choke valve during warming up period 3. Checking the main circuit (a) Purpose of the main circuit; transition phase (b) Functioning of the main circuit: Path of the gasoline and air Methods of metering gasoline to the discharge nozzle: Metering pins, metering Purpose of the jets, air bleeds, primary. and secondary venturi, jet size (c) Mixing: mixture ratio, economy mixture, turbulence, atomization

UNIT 1: Single Barrel Carburetor

#### **OPERATIONS**

#### KNOWLEDGE

- 4. Checking the power circuit and component parts
- (a) Purpose of the circuit
- (b) Functioning of the circuit:

  Path of the gasoline and air

  Methods of metering the gasoline
  Vacuum metering and channels

  Mixture ratio, Power mixture

  Time control of the power circuit
- 5. Checking the accelerating circuit and component parts
- (a) Purpose of the circuit
- (b) Functioning of the circuit:

  Path of the gasoline. Aiming of the jet
  Function of the check valves
  Seasonal adjustment of the piston stroke. Pump
  linkage
  Mixture ratio during acceleration
  Time duration of the injection Prolonged
  injection aiming the jet
- (c) Types of pump: piston, diaphragm
- (d) Pump setting gauge
- 6. Checking and adjusting the float level
- (a) Types of float used
- (b) Importance of proper float setting
- (c) Use of float setting gauges
- (d) Single & double float system
- (e) Needle valve and seat assembly
- (f) Causes of needle sticking-Needle valve seating pressure
- 7. Checking and adjusting the automatic choke
- (a) Function of the automatic choke
- (b) Types of automatic choke: direct mounting manifold mounting
- (c) Functioning of the automatic choke
- (d) Unbalanced choke valve
  - (e) Thermostat spring heating control: hot airelectrical
  - (f) Thermostatic spring adjustment
- (g) Choke cracking device Unloading device
- (h) Fast idling device
- (i) Linkage adjustment

UNIT 1: Single Barrel Carburetor

OPERATIONS	KNOWLEDGE
OI TRAIL TOWN	
8. Checking the auxiliary components	<ul> <li>(a) Function of the air filter, types of air filter. Servicing air filter</li> <li>(b) Function of the dash pot, types of slow closing throttle devices. Adjustment</li> <li>(c) Purpose &amp; functioning of carburetor mounted starter switch. Adjustment</li> <li>(d) Purpose &amp; functioning of kick down switch</li> <li>(e) Purpose &amp; functioning of the manifold heat control valve</li> </ul>
9. Repairing or replacing defective parts	<ul><li>(a) How to file and lap mating surfaces according to manufacturers' manuals</li><li>(b) How to inspect and replace gaskets according to specifications</li></ul>
10. Trouble finding	<ul> <li>(a) Effect of air leak at the manifold gaskets</li> <li>(b) Effect of low float setting</li> <li>(c) Effect of high float setting</li> <li>(d) Effect of improper mixture</li> <li>(e) How to determine the proportion of the mixture with a gas analyser</li> <li>(f) Effect of a rich mixture, a lean mixture.  Causes</li> <li>(g) Effect of a leak at the power valve</li> <li>(h) Effect of a leak in the vacuum passage to the power cylinder</li> <li>(i) Effect of a leak at the check valves</li> <li>(j) Causes of poor acceleration</li> <li>(k) Effect of choke valve not closing or opening properly</li> <li>(l) Effect of improper functioning of the heat control valve</li> <li>(m) Causes and effect of carburetor icing</li> </ul>

trouble finding

UNIT 2: Dual and Quadruple

**OPERATIONS** KNOWLEDGE Note: Some general information is required as in corresponding operations in connection with Single Carburetors. Additional applicable features are listed below. 1. Disassembling the carburetor (a) Purpose of dual and quadruple carburetors 2. Checking the idling and fast (a) Inter-relation of the idling circuits idling circuits and com-(b) Synchronism of the throttle valves (c) Cylinders fed by each carburetor ponent parts (d) Inter-relation of throttle valve linkage (four barrels) (e) Purpose of secondary throttle valve locking device (four barrels) (f) Idling speed adjusting screws (a) Inter-relation of main circuits 3. Checking the main circuits (b) Linkage time control of the secondary throttle and component parts opening (four barrels) (c) Vacuum time-control of the secondary throttle opening (four barrels) (d) Purpose of auxiliary valves above secondary throttle valves (four barrels) 4. Checking the power circuits (a) Inter-relation of the power circuits and component parts (a) Inter-relation of the accelerating circuits 5. Checking the accelerating (b) Mechanical or vacuum controlled pumps circuits and component parts (a) Inter-relation of float chambers 6. Checking and adjusting the (b) Gas level stability control float setting (c) Float motion damping device 7. Checking and adjusting the (a) Choke valve arrangement (b) Inter-relation of choke valve and auxiliary automatic choke valves of secondary carburetor (four barrels) (c) Inter-connection between choke valve and throttle valves (four barrels) 8. Checking auxiliary components, (a) Conditions that warrant replacing parts replacing defective parts and

(51)

## Block 13: Fuel and Exhaust Systems - Fuel and Vacuum Pumps

#### TABLE OF CONTENTS

	ENERGY OF ACTUALISM
Unit 1:	Fuel Pumps Page 53
	Operation 1. Disassembling the pump 2. Checking the cover assembly 3. Checking the body assembly 4. Repairing or replacing defective parts 5. Trouble finding
Unit 2:	Fuel and Vacuum Pump Combined Page 55
	Operation 1. Disassembling the pump 2. Checking the cover assembly 3. Checking the body assembly 4. Repairing and replacing defective parts 5. Trouble finding

BLOCK 13: Fuel and Vacuum Pumps UNIT 1: Fuel Pumps

OPERATIONS	KNOWLEDGE
1. Disassembling the pump	<ul> <li>(a) Function of the pump</li> <li>(b) Types of pumps: mechanical, electrical</li> <li>(c) Direct or remote actuation</li> <li>(d) Mounting methods</li> <li>(e) Sub assembly: Cover, body, filter, linkage</li> <li>(f) Type of pipe fittings</li> </ul>
2. Checking the cover assembly	<ul> <li>(a) Types, function and location of the valves</li> <li>(b) Function of the air dome chamber</li> <li>(c) Path of the gas through the cover</li> <li>(d) Type of filtering element. Methods of fastening cover to the body</li> </ul>
3. Checking the body assembly	<ul> <li>(a) Variable diaphragm stroke controlled by float level</li> <li>(b) Composition of the diaphragm</li> <li>(c) Pumping action of the diaphragm. Pump pressure control</li> <li>(d) Function of the diaphragm spring</li> <li>(e) Events taking place on the compression stroke of the diaphragm</li> <li>(f) Events taking place during the intake stroke of the diaphragm</li> <li>(g) Overrunning rocker arm drive to diaphragm stem</li> <li>(h) Overdrive, underdrive rocker arm. Function of rocker arm spring</li> <li>(i) Straightness of the mating surfaces</li> </ul>
4. Repairing or replacing defective parts	(a) Study of the manual instructions (b) Proper methods of assembling parts
5. Testing fuel pump in place	<ul><li>(a) How to test for capacity</li><li>(b) How to test for pressure</li><li>(c) Pump pressure range</li><li>(d) How to test pump vacuum</li></ul>

BLOCK 13: Fuel and Vacuum Pumps UNIT 1: Fuel Pumps

OPERATIONS	KNOWLEDGE
6. Trouble finding	(a) Causes and effect of excess pressure (b) Causes and effect of insufficient pressure
	(c) Effect of worn linkage
	(d) Causes and effect of insufficient pump capacity
	(e) Causes and effect of vapor lock
	(f) Advantages of pusher electric pump over mechanical suction pump

BLOCK 13: Fuel and Vacuum Pumps UNIT 2: Combined Type

OPERATIONS	KNOWLEDGE
1. Disassembling the pump (a	Function and operation of the fuel and vacuum pump
(b) (c) (d) (e) (f) (g)	Difference in construction between the fuel and vacuum covers Path of the gas through fuel cover Path of the air through vacuum pump cover Difference between fuel and vacuum check valves Manifold vacuum and vacuum pump in series Rest periods of the vacuum pump Variable fuel diaphragm stroke controlled by the float level Variable vacuum diaphragm stroke controlled by engine vacuum
(b) (c) (d) (e)	Mounting of the fuel and vacuum diaphragm Overrunning rocker arm links Function of the vacuum diaphragm spring Purpose of the larger vacuum pump diaphragm Factors controlling the fuel pump capacity Factors controlling the vacuum pump capacity
	) Study of the manual instructions ) Proper methods of assembling parts
the second secon	) How to test fuel pump pressure and capacity ) How to test the vacuum valve of the vacuum pump

BLOCK 13: Fuel and Vacuum Pumps UNIT 2: Combined Type

OPERATIONS KNOWLEDGE (a) Causes and effect of excessive fuel 6. Trouble finding pressure (b) Causes and effect of insufficient fuel pressure (c) Causes and effect of insufficient pump capacity (d) Effect of air leaks at the suction line

of the vacuum pump (e) Effect of leaky vacuum pump valves

(f) Causes of oil being sucked into the intake manifold

# Block 14: Fuel and Exhaust Systems - Components of the Carburetion System

## TABLE OF CONTENTS

## Block Fourteen - One Unit

Ope	ration		Page
	1.	Checking the Gas Tank	58
	2.	Checking Intake Manifold	58
	3.	Checking Air Filter and Silencer	58
	4.	Checking the Muffler	58
	5.	Checking diesel fuel injection system	59
	6.	Trouble finding	59

Components of the UNIT 1: Servicing Procedures
Carburetion System BLOCK 14: Components of the

OPERATIONS	KNOWLEDGE
1. Checking the gas tank	<ul> <li>(a) Tank mounting. Components of the tank</li> <li>(b) Type of gas level indicator tank unit</li> <li>(c) Provision for sediment separation</li> <li>(d) How to syphon gas out of tank</li> <li>(e) Risk of vapor lock between tank and pump</li> <li>(f) Necessity of air vent at the tank filler pipe</li> <li>(g) Importance of air tight fuel pipe fittings</li> <li>(h) Causes of water condensation in the tank</li> <li>(i) Related science: Pressure on a liquid and its vapor point</li> </ul>
2. Checking intake manifold and components parts	<ul> <li>(a) Function and location of the manifold gaskets</li> <li>(b) Manifold balanced circuits. Manifold variable cross section</li> <li>(c) Function and location of the heat riser</li> <li>(d) Function and location of the heat valve</li> <li>(e) Thermostatic control and adjustment of the heat valve</li> <li>(f) Relation of the intake to the exhaust manifolds</li> </ul>
3. Checking and servicing the air filter and silencer	<ul><li>(a) Types of filter. Mounting of the air filter</li><li>(b) Function of the air filter. Function of the resonating chambers</li></ul>
4. Replacing the muffler	<ul> <li>(a) Function of the muffler</li> <li>(b) Construction and location of the muffler</li> <li>(c) Back pressure created by the exhaust circuit</li> <li>(d) Related science: Acoustics - Sound waves</li> </ul>

#### AN ANALYSIS OF THE MOTOR VEHICLE REPAIR TRADE

BLOCK 14: Components of the

Carburetion System

UNIT 1: Servicing Procedures

OPERATIONS KNOWLEDGE 5. Checking diesel fuel (a) Principle of fuel injection injection system (b) Components of injection system 6. Trouble finding (a) Causes and effect of water condensation in fuel system (b) Causes and effect of vapor lock (c) Causes and effect of air leaks at the manifold gaskets (d) Effect of a heat valve not operating properly (e) Effect of a clogged air filter (f) Causes and effect of back pressure in the exhaust circuit (g) Causes and effect of lean mixture

#### Block 15: Electrical Systems - Basic Science

#### TABLE OF CONTENTS

Study of the topics indicated below provides basic knowledge and information which should be familiar to journeymen in the mechanical phases of the trade and therefore should be included in the training program.

- 1. Study of current, both AC and DC, voltage, voltage drop, amperage
- 2. Definition of conductor, insulator, terminal, generator
- 3. Definition of circuit (1) closed (2) open (3) short (4) series (5) parallel
- 4. Study of resistance (Ohm's Law), watt, power
- 5. Definition of magnetism, magnetic field, lines of force, poles (i) positive (ii) negative, magnetic circuit, electro-magnet
- 8. Advantages of the 12 volt system

Note: The trade recognizes the complexity of power driven devices and of the circuits controlling same and accordingly agrees that the auto-mechanic need be required to master only such features as the following (a) the layout of circuits (b) the function of various components (c) the nature and use of measuring instruments such as the voltmeter and ammeter.

## Block 16: Electrical Systems - The Battery

## TABLE OF CONTENTS

## Block Sixteen - One Unit

Operation		Page
1.	Servicing the Battery	62
2.	Testing the Battery	62
3.	Charging the Battery	62
4.	Repairing	62
5.	Trouble Finding	63

BLOCK 16: Battery UNIT 1: Servicing

	OPERATIONS	KNOWLEDGE
1.	Servicing the battery	<ul> <li>(a) Function of the battery</li> <li>(b) Types of battery: lead-iron-nickel</li> <li>(c) Function of the components: plates, separators, cell, electrolyte</li> <li>(d) Reactions taking place during charge and discharge</li> <li>(e) Active material-Reaction with acid</li> <li>(f) Connection of cells and voltage</li> <li>(g) Batteries connected in series, in parallel</li> <li>(h) Care of batteries in storage</li> <li>(i) How to remove, fasten and replace cables</li> </ul>
2.	Testing the battery	<ul> <li>(a) Capacity test: slow discharge, heavy discharge</li> <li>(b) High rate discharge tester</li> <li>(c) Level of the electrolyte</li> <li>(d) Temperature effect on capacity</li> <li>(e) Battery rating</li> <li>(f) Science related to specific gravity, hydrometer, distilled water, sulphuric acid</li> </ul>
3.	Charging the battery	<ul> <li>(a) How to tell when a battery is charged</li> <li>(b) Chargers: bulb charger, constant potential charger, rapid charger, trickle charger. Charging current and voltage</li> <li>(c) How to prepare the electrolyte</li> <li>(d) Battery self discharge at rest</li> <li>(e) Battery charging temperatures</li> <li>(f) Temperature effect on electrolyte conductivity</li> <li>(g) Safety: Explosive gas formation</li> </ul>
4.	Repairing a battery	<ul> <li>(a) Rebuilding a battery post</li> <li>(b) Replacing a battery case</li> <li>(c) Replacing a cell cover</li> <li>(d) Resealing with battery pitch</li> <li>(e) Corrosion preventive</li> </ul>

## AN ANALYSIS OF THE MOTOR VEHICLE REPAIR TRADE

BLOCK 16: Battery

UNIT 1: Servicing

OPERATIONS	KNOWLEDGE
5. Trouble finding	<ul> <li>(a) Causes and effect of sulphation</li> <li>(b) Causes and effect of plate shedding</li> <li>(c) Causes and effect of overheated plates</li> <li>(d) Separator trouble</li> <li>(e) Post corrosion</li> <li>(f) Causes and effect of overcharge</li> <li>(g) Causes and effect of undercharge</li> </ul>

## Block 17: Electrical Systems - The Generator

## TABLE OF CONTENTS

## Block Seventeen - One Unit

Operation			Page
	1.	Removing and Disassembling the Generator	65
	2.	Testing the Generator	65
	3.	Repairing and installing the Generator	66
	4.	Trouble Finding	66

BLOCK 17: Generator

UNIT 1: Various Techniques

#### OPERATIONS

#### KNOWLEDGE

- 1. Removing and disassembling the generator
- (a) Function of the generator; driving methods; belt tension; pulley removal
- (b) Construction and purpose of the component parts: armature, commutator, field coils, field poles, brushes, brush springs, bearings
- (c) Two pole, four pole generator
- (d) Armature circuit, field circuit, air gap and its effect
- (e) Difference between a three brush and shunt generator
- (f) Position of the third brush and effect on the charging rate
- (g) Offset brushes. Reaction brush holder
- (h) Connection of the armature coils to the commutator bars
- (i) Path of the current through the armature circuit
- (j) Path of the current through the field circuit
- (k) Terminal "F" to ground type of generator
- (1) Terminal "F" to terminal "A" type of generator
- 2. Testing the generator
- (a) Testers used: 110 volt test leads, 6 volt test leads, growler, ammeter, voltmeter
- (b) How to test armature coils for shorted, opened, grounded, resistance and reversed coils; standard test procedure
- (c) How to test field coils for conditions in (b)
- (d) Condition of the commutator
- (e) Provision for lubrication of bearing and bushing; how to test bearings
- (f) Motoring the generator
- (g) How to locate the neutral point on commutator
- (h) How to test armature run out, commutator run out
- (i) Brushes: composition, hard brush, semi-hard brush, soft brush. Brush alignment and seating
- (j) Brush position on the commutator
- (k) How to test the brush carrier
- (1) How to test brush spring tension, the armature air gap
- (m) Brushes end plate. Aligning marks or dowel pins
- (n) How to test generator in place

BLOCK 17: Generator

# UNIT 1: Various techniques

OPERATIONS	KNOWLEDGE
3. Repairing and installing the generator	<ul> <li>(a) How to resolder armature coil leads to commutator</li> <li>(b) How to true-up a commutator on the lathe</li> <li>(c) Why and how to undercut the mica. Mica undercuter</li> <li>(d) Bearing removal and replacement</li> <li>(e) How to remove and replace a bushing. Reaming the bushing</li> <li>(f) How to polarize the generator</li> <li>(g) How to replace field coils &amp; poles</li> <li>(h) How to test polarity of field coils &amp; poles</li> <li>(i) How to seat brushes</li> <li>(j) How to locate the brushes lengthwise on the commutator</li> </ul>
4. Trouble finding	<ul> <li>(a) Causes and effect of generator over-heating</li> <li>(b) Causes and effect of brush arcing</li> <li>(c) What causes an armature to burn</li> <li>(d) What causes the field coils to burn</li> <li>(e) Causes of commutator bars pitting</li> <li>(f) Causes of generator low out-put</li> <li>(g) Causes of generator high out-put</li> <li>(h) Causes of bearing failure</li> </ul>

# Block 18: Electrical Systems - Charging Circuits

## TABLE OF CONTENTS

Unit 1	Voltage ar	nd ci	errent regulator and cut-out relay	Page 68
	Operation	1.	Checking	
		2.	Repairing and adjusting	
		3.	Trouble finding	
Unit 2	Miscellane	eous	procedures	Page 69
	Operation	1.	Checking and adjusting the charging circuit	
		2.	Trouble finding	

BLOCK 18: Charging Circuits

UNIT 1: Voltage and current regulator and cut-out relay

## KNOWLEDGE OPTRATIONS 1. Checking the voltage and (a) Function of the regulators Function of the cut-out current regulator and cutout relay (b) Purpose of the components: magnet core, voltage winding, series winding, field resistance, induced current by-pass resistance (c) Path of the current in the voltage regulator circuit (d) Path of the current in the current regulator (e) Path of the current in the cut out circuit (f) Closing voltage of the cut-out points, reversed opening current. Two steps closing of the Autolite cut-out points (g) Vibrating voltage regulator, two steps voltage regulator (h) Polarity and its effect on metal deposit (i) Oxidation of points and corrective methods (j) Current carrying capacity of regulator points (k) How to test regulator in place (a) How to change the closing and opening 2. Repairing and adjusting operating point of the cut-out relay (b) How to change the operating voltage of the V.R. (c) How to change the operating current of the C.R. (d) Air gap setting. Effect on vibration frequency (e) Demagnetizing winding (f) Use of ohmmeter. Effect of resistance on the sparking of regulator points. Effect of resistance on the induced voltage (g) Regulator points replacement (h) Temperature compensation (i) Polarity: direction of current through regulator points, metals used for regulator points (j) Causes of oxidation of the regulator points; how to clean contact points (k) Cushion mounted regulator box (1) Necessity of perfect grounding the regulators (m) How to clean contact points

3. Trouble finding

- (a) Effect of oxidized points
- (b) Causes of low charging current
- (c) Causes of high charging current
- (d) Causes of vibrating cut-out points
- (e) Effect of defective grounding of the regulators

BLOCK 18: Charging Circuits UNIT 2: Checking Procedures

OPERATIONS	KNOWLEDGE
	a) How to test the battery
the charging circuit	b) How to test conductors, insulators, terminals, junction blocks
(	c) How to connect the voltmeter and ammeter in
· ·	the circuit
(	d) Function of the charging resistance
(	e) How to change the value of the current and
	voltage
	f) How to determine the polarity of the circuit g) Difference between the 6 and 12 volts system
	h) Study of the specifications
	i) Winter and summer setting of the voltage
	regulator
	j) Path of the current through the circuit
(	k) Relation of all the circuits to the charging
	circuit  1) How to determine the voltage drop of the
`	charging circuit
	m) Parasitic resistances and their effects
	n) Ammeter location in the circuit and its
	indications
(	(o) How to locate the defective parts of the circuit in place
(	(p) Location and function of the charge indicator-
	light
0 500	(a) Causes and effect of excessive voltage drop
	(a) Causes and effect of excessive voltage drop (b) Effect of undersized conductors
	(c) Causes of undercharged battery
	(d) Causes of overcharged battery

# Block 19: Electrical Systems - Ignition

# TABLE OF CONTENTS

Unit 1:	Various Compon	nents and Procedures	Page 71
	Operation 1.	Testing the coil	
	2.	Testing and repairing the breaker mechanism and distributor	
	3.	Testing and adjusting spark plugs	
Unit 2:	Miscellaneous	Techniques	Page 73
	Operation 1.	Checking the Ignition Circuit	
	2.	Spark timing	
	3.	Trouble finding	

BLOCK 19: Ignition

UNIT 1: Various Components and Procedures

OPERATIONS

#### KNOWLEDGE

1. Testing the coil

- (a) Function of the coil
- (b) Construction of the coil. Primary & secondary winding
- (c) Factors controlling the secondary induced voltage and current
- (d) Voltage peak insulation. Oil & dry insulation
- (e) Operation of coil tester: spark gap type, electronic type
- (f) Coil capacity: Heavy duty coil, standard coil
- (g) Transformer action of the coil
- (h) Relation between capacity of coil and condenser
- (i) Coil polarity
- (j) Coil saturation period
- 2. Testing & repairing the breaker mechanism and distributor
- (a) Function of the breaker mechanism
- (b) Cam angle. Effect of large & small cam angle
- (c) Breaker points construction & mounting
- (d) Double set of points system; Advantages
- (e) Purpose & function of condenser: Leakage, damping, capacity tests
- (f) Purpose & functioning of centrifugal advance Test of the advance on a distributor tester
- (g) Functioning and use of a distributor tester
- (h) Purpose & functioning of the vacuum advance
  Test of the vacuum advance
- (i) Effect of spring tension on the breaker points action. Test of the spring tension
- (j) Relation between condenser capacity and gap of points
- (k) Check of the cam wobble
- (1) Replacement of cam shaft bushings
- (m) Rotor & distributor cap insulation
- (n) Purpose of the rotor air gap
- (o) Cap inserts corrosion Preventive methods
- (p) How to clean contact points
- (q) How to synchronize double breakers
- (r) Setting gap for same
- (s) Lubrication
- (t) How to time double breakers

BLOCK 19: Ignition

UNIT 1: Various Components

and Procedures

OPERATIONS

KNOWLEDGE

3. Testing & adjusting spark plugs

- (a) Construction & function of the spark plug
- (b) Heat range: hot & cold plugs
- (c) Radio interference. Elimination with resistor
- (d) Sand blast cleaning
- (e) Plug gapping. Compromise between low & high speed requisite
- (f) Tightening pressure & shell distortion
- (g) Plug size and heat dissipation
- (h) Use of spark plug tester
- (i) How to test spark plugs in and out of place
- (j) Gaskets and various types of seats

BLOCK 19: Ignition

UNIT 2: Miscellaneous Techniques

OPERATIONS	KNOWLEDGE
1. Checking the ignition circuit	<ul> <li>(a) Function of the primary &amp; secondary circuits</li> <li>(b) Transfer of energy from primary to secondary</li> <li>(c) Factors controlling the quality of the spark</li> <li>(d) Oscillatory discharge at the spark plug</li> <li>(e) Factors controlling the induced voltage at the secondary</li> <li>(f) Function of a resistance at the coil</li> <li>(g) Comparison of 6 &amp; 12 volts systems</li> <li>(h) Voltage drop in the circuit</li> <li>(i) Coronary effects</li> <li>(j) Length of the secondary circuit and capacity effect</li> <li>(k) Secondary cables shield and capacity effect</li> <li>(l) Added resistance in the secondary and its effect on the condenser capacity</li> <li>(m) Check of the secondary cables</li> </ul>
2. Ignition timing	<ul> <li>(a) Use of timing light. Timing to the timing mark</li> <li>(b) Timing to the knocking or 'pinging' point</li> <li>(c) Function &amp; setting of ignition timing for fuels of various octane ratings</li> <li>(d) Check of the centrifugal advance with timing light</li> <li>(e) Check of the vacuum advance with timing light</li> <li>(f) Determination of the firing order</li> <li>(g) Factors controlling the spark timing. Use of vacuum gauge</li> </ul>
3. Trouble finding	<ul> <li>(a) Causes &amp; effect of pitted breaker points, burned points</li> <li>(b) Causes &amp; effect of pre-ignition (spark knock)</li> <li>(c) Causes of open throttle miss</li> <li>(d) Causes of high speed miss</li> <li>(e) Causes of ignition knock</li> <li>(f) Causes of low speed miss</li> <li>(g) Causes of radio interference</li> </ul>

# Block 20: Electrical Systems - Starters

# TABLE OF CONTENTS

		n Adjusting the Starter arter Switch Page 75
	Operation 1.	Removing and Disassembling the Starter
	2.	Testing and Repairing the Starter
	3.	Testing and Adjusting the Starter Switch
	4.	Trouble finding
Unit 2:	Starter Circu	lits Page 77
	Operation 1.	Check and Adjust Starter Circuit
	2.	Trouble Finding

BLOCK 20: Starters

UNIT 1: Servicing the Starter and Starter Switch

#### **OPERATIONS**

#### KNOWLEDGE

- 1. Removing and disassembling the starter
- (a) Functioning principle of the starter (b) Construction & purpose of the component parts: Armature, commutator, field coils, field poles, brushes
- (c) Two pole, four pole starter
- (d) Armature circuit, field circuits
- (e) Air gap and its effect
- (f) Starter drives; construction & operation
- (g) Difference between 6, 12 and 24 volt starter
- (h) Why higher voltage circuits are more efficient
- (i) Factors controlling the power of the starter
- (j) Related science: Inertia, thermal and electrical conductivity, shock absorbing devices

2. Testing and repairing the starter

- (a) Testers used: 110 volt test leads, six volt test leads, growler, ammeter. voltmeter
- (b) How to test for shorted, open and grounded armature coils; also for high resistance in soldered joints
- (c) How to test for shorted, open, grounded and high resistance field coils
- (d) Condition of the commutator
- (e) Armature bushings wear and its effect on the air gap
- (f) Brushes: Location on the commutator, composition, spring tension, alignment, seating, replacing
- (g) Free running test. Cranking test(h) Lock torque test. Voltage drop test
- (i) How to test starter drive
- (j) How to true up the commutator
- (k) How to undercut mica
- (1) How to ream and replace bushings
- (m) How to remove and replace a ring gear
- (n) How to replace field coils

#### AN ANALYSIS OF THE MOTOR VEHICLE REPAIR TRADE

BLOCK 20: Starters

UNIT 1: Servicing the Starter and Starter Switch

OPERATIONS

KNOWLEDGE

3. Testing & adjusting (a) Types of switch: manual, solenoid starter switch (b) Solenoid principle (c) Solenoid windings: pulling, holding coils (d) Relay operated solenoid; adjustment (e) Switch contact pressure & voltage drop

4. Trouble finding (a) Causes & effect of starter over-heating (b) Causes & effect of brush arcing

(c) Effect of improperly adjusted solenoid relay

(d) Causes of insufficient power

BLOCK 20: Starters

UNIT 2: Starter Circuits

OPERATIONS	KNUWLEDGE
1. Checking & adjusting starter circuit	<ul> <li>(a) Functioning and use of a shunt ammeter</li> <li>(b) Capacity test of the battery</li> <li>(c) Gauge and current carrying capacity of cables</li> <li>(d) Corrosion of the battery posts. Ground connection</li> <li>(e) Voltage drop produced by the starter current and its effect on the ignition circuit</li> <li>(f) Determination of the cranking current</li> <li>(g) Determination of the cranking voltage</li> <li>(h) Rest periods and battery recuperation</li> <li>(i) Voltage drop allowed in the circuit</li> <li>(j) Path of the current in the solenoid relay circuit</li> <li>(k) Path of the current in the solenoid winding circuits</li> <li>(l) Path of the current in the starter circuits</li> </ul>
2. Trouble finding	<ul> <li>(a) Causes of low cranking speed</li> <li>(b) Causes of drive pinion not meshing (Bendix)</li> <li>(c) Causes of drive pinion failure to disengage</li> <li>(d) Causes of armature coils forced out of the slot</li> <li>(e) Causes of Bendix drive pinion locking on the ring gear</li> </ul>

# Block 21: Electrical Systems - Lighting

## TABLE OF CONTENTS

Unit 1:	Main Circu	its	and Components	Page 79
	Operation	1:	Checking and adjusting headlight circuits	
		2:	Checking and adjusting (a) Tail light circuit (b) Stop light circuit (c) Licence light circuit (d) Parking light circuit	
		3:	Trouble finding	
Unit 2:	Auxiliary	Cir	cuits	Page 80
	Operation	1:	Checking such circuits as dome light, trunk light	
		2:	Checking directional light circuits	

BLOCK 21: Lighting

UNIT 1: Main Circuits and Components

#### **OPERATIONS**

#### KNOWLEDGE

- 1. Checking and adjusting headlight circuits
- (a) Types of sealed beams: glass unit, composite unit
- (b) Assembly and mounting of the sealed beam lamps. Function of reflector, lens and filament
- (c) Lamp rating: Candle power, wattage
- (d) Driving beam, passing beam, aiming alignment
- (e) Switches: Main lighting switch, high-low beam
- (f) Circuit protection: Fuses, circuit breakers
- (g) Path of the current through the circuit(h) Voltage drop in the circuit with 6 and 12 volt bulbs
- (i) Purpose of a lighting circuit relay
- (j) Wire color code, wire gauges
- (k) Tracing a circuit in wiring diagrams
- (1) Parallel and series circuits. Type and location of connectors
- (m) Sealed beam unit replacement and adjusting
- (n) Related science: Light diffusion through crystal, parabolic reflector, focal point, illuminating distances, stopping distances
- (o) How to detect and locate short circuits
- 2. Checking and adjusting circuits for:
   Parking lights
   Tail lights
   Stop lights
   Back-up lights
- (a) Operation, location and mounting of parking lights and switches for same
- (b) Also tail lights, stop lights and backup lights
- (c) Light bulb rating (candle power)

3. Trouble finding

- (a) Causes of dull headlights
- (b) Causes of light intensity fluctuating with the speed
- (c) Causes of short bulb life
- (d) Effect of improper grounding

BLOCK 21: Lighting

UNIT 2: Auxiliary circuits

OPERATIONS	KNOWLEDGE
1. Checking the auxiliary light circuits	<ul> <li>(a) Function and location of instrument lights</li> <li>(b) Function and location of the dome light,</li> <li>trunk light</li> <li>(c) Wire gauge and color code. Bulb rating in candle power</li> </ul>
	(d) Function and location of the backing up lights (e) Circuit protection: Fuses, circuit breakers (f) Purpose of junction blocks, fuse block
2. Checking directional light circuits	<ul> <li>(a) Function and location of the turn signal lights</li> <li>(b) Importance of using bulbs of proper candle power</li> <li>(c) Functioning and testing of the flasher unit</li> <li>(d) Construction and functioning of the switch</li> <li>(e) Automatic return to the "off" position</li> <li>(f) Checking the circuits with voltmeter</li> </ul>

# Block 22: Electrical Systems - Accessories

## TABLE OF CONTENTS

Unit 1:	Horns		Page 82
	Operation 1:	Checking and adjusting the horn	
	2:	Trouble finding	
Unit 2:	Windshield Wip	pers and Washers	Page 83
	Operation 1:	Checking and adjusting the wiper and component	
	2:	Trouble finding	

BLOCK 22: Accessories UNIT 1: Horns

OPERATIONS	KNO WLEDGE
1. Checking and adjusting the horn	<ul> <li>(a) Types of horn: rotary, vibrator</li> <li>(b) function of horn sub-assembly: electro magnet, armature, diaphragm breaker points</li> <li>(c) By-passing the induced current with a condenser or a resistance</li> <li>(d) Induced voltage at the opening of the points</li> <li>(e) Adjustment controlling the pitch of the sound</li> <li>(f) Adjustment controlling the intensity of the sound</li> <li>(g) Dual pitch horns. Blending of tones</li> <li>(h) Purpose and functioning of the horn relay</li> <li>(i) Mounting of the horn button or ring on the steering wheel</li> <li>(j) Path of the current through the horn button circuit</li> <li>(k) Path of the current through the horn circuit</li> <li>(l) Purpose of a flexible horn mounting</li> <li>(m) Science: Sound, principle of the muffler, tone blending, vibration frequency</li> </ul>
2. Trouble finding	<ul> <li>(a) Causes of sound distortion</li> <li>(b) Causes of points sticking</li> <li>(c) Causes of intermittent operations</li> <li>(d) Causes of horn breaker-points</li> <li>pitting and burning</li> </ul>

# AN ANALYSIS OF THE MOTOR VEHICLE REPAIR TRADE

BLOCK 22: Accessories

UNIT 2: Windshield Wipers and Washers

OPERATIONS	KNO NLEDGE
l. Servicing windshield wipers and washers	<ul> <li>(a) Nethods of mounting wiper components     Types of wiper motors: vacuum, electric</li> <li>(b) Types of transmission: links, cables</li> <li>(c) Wiper blade construction and mounting</li> <li>(d) Functioning of the vacuum motor</li> <li>(e) Functioning of the electric motor</li> <li>(f) Automatic blade parking circuit</li> <li>(g) Two speed electric motor</li> <li>(h) Path of the current through the circuit</li> </ul>
2. Trouble finding	<ul> <li>(a) Effect of air leak on a vacuum-actuated wiper</li> <li>(b) Causes of sluggish wiper operation</li> <li>(c) Causes of failure to operate</li> </ul>

# BLOCK 23: Electrical Systems - Gauge Circuits

## TABLE OF CONTENTS

# Block Twenty-Three - One Unit

Operation		Page
1:	Checking fuel gauge circuit	85
2:	Checking water temperature gauge circuit	85
3:	Checking oil pressure gauge circuit	85

BLOCK 23: Gauge Circuits UNIT 1: Servicing Various Components

OPERATIONS	KNOWLEDGE
1. Checking the dash fuel gauge or light circuit	<ul> <li>(a) Fuel tank unit: construction, functioning</li> <li>(b) Dash unit types: magnetic, thermal. Construction &amp; functioning</li> <li>(c) Path of the current through the circuit</li> <li>(d) How to test tank and dash units</li> </ul>
2. Checking the water temperature gauge circuit	<ul> <li>(a) Engine unit: construction &amp; functioning</li> <li>(b) Dash unit: construction &amp; functioning</li> <li>(c) Bi-metal thermostatic action</li> <li>(d) Path of the current through the circuit</li> <li>(e) How to test engine &amp; dash unit</li> </ul>
3. Checking the oil pressure gauge circuit	<ul> <li>(a) Engine unit: construction &amp; functioning</li> <li>(b) Dash unit: construction &amp; functioning</li> <li>(c) Path of the current through the circuit</li> <li>(d) How to test engine &amp; dash units</li> </ul>

## Block 24: Motor Tune-up - Miscellaneous Techniques

## TABLE OF CONTENTS

# Block Twenty-four - One Unit

Operation		Page
1.	Checking Compression	87
2.	Checking the Ignition System	87
3.	Checking and Adjusting the Fuel System	87
4.	Checking and Adjusting the Cooling System	88
5.	Checking and Adjusting the Lubricating System	88
6.	Checking Motor Performance Before and after Tune-up	88

BLOCK 24: Motor Tune-up

UNIT 1: Miscellaneous Techniques

**OPERATIONS** 

#### KNOWLEDGE

- 1. Checking compression
- (a) Factors controlling the performance of a motor

(b) How to determine the compression ratio

(c) Factors controlling the compression: Valves, rings, cylinders, pistons, lubricating oil, piston speed

(d) Increased power due to high compression

- (e) Compression proportional to throttle opening
- (f) Allowable variation in compression between cylinders
- (g) How to tell if compression leak exists at the valves or cylinders
- (h) Relation between compression and vacuum
- 2. Checking the ignition system (Refer to Block 19)
- (a) Factors controlling the quality of the spark

(b) How to test the quality of the spark

(c) How to set the spark timing

- (d) Factors affecting the spark timing: Gasoline octane number, compression value, carbonized chambers
- 3. Checking and adjusting the fuel system (Refer to Blocks 12 and 13)
- (a) How to test the pump pressure

(b) How to test the pump capacity

(c) How to check the float setting and gas level

(d) How to check the choke operation

(e) How to check the carburetor linkage

- (f) How to adjust the idling speed. Use of the tachometer
- (g) Automatic transmission idling speed setting in drive position. Automatic transmission idling speed in neutral position

(h) How to check the fast idling cam position

and linkage

(i) How to adjust the idling speed mixture with vacuum gauge and gas analyser

(j) How to check main, power and acceleration circuits with gas analyser

- (k) How to check the functioning of the manifold heat control valve
- (1) Effect of rich and lean mixtures on: Operating temperature of the motor, power produced, economy
- (m) Cause of blue black and white smoke at the exhaust

#### AN ANALYSIS OF THE MOTOR VEHICLE REPAIR TRADE

BLOCK 24: Motor Tune-up

UNIT 1: Miscellaneous Techniques

## **OPERATIONS** KNOWLEDGE (a) Refer to Block 26 on cooling system 4. Checking & adjusting cooling system 5. Checking & adjusting (a) Refer to Block 4 on lubricating lubricating system system (a) Factors controlling engine vacuum 6. Checking motor performance before and after tune-up (b) Principle of the vacuum gauge (c) Use of vacuum gauge to determine valve operations condition, ring condition, condition of carburetion system, spark and valve timing (d) Use of vacuum gauge to compare output of each cylinder, individually

Block 25: Electrical Systems: Power Actuated Units

## TABLE OF CONTENTS

# Block Twenty-Five - One Unit

Operation		Page
1.	Checking circuits for electric window lifts and components	90
2.	Checking circuits for power actuated tops and components	90
3.	Checking circuits for power actuated seats and components	90
4.	Trouble finding	90

BLOCK 25: Power Actuated Units UNIT 1: Servicing Windows, Seats and Tops

OPERATIONS	KNOWLEDGE
1. Checking circuits for electric window lifts and components	<ul> <li>(a) Components of window lift mechanism: motor, switch, relays, circuit breaker, linkage</li> <li>(b) How to reverse the rotation of a D.C. motor</li> <li>(c) How the motor is protected from overload</li> <li>(d) Linkage between motor and glass. Free action in glass run channels</li> <li>(e) Functioning of double poles, double throw switches</li> <li>(f) Functioning of the relays</li> <li>(g) Path of the current through door switch circuits</li> <li>(h) Path of the current through motor circuits</li> <li>(i) Checking current draw with ammeter</li> </ul>
2. Checking circuits for power actuated tops and components	<ul> <li>(a) Components of the power-top mechanism: motor, switch, relay, pump, hydraulic cylinder, linkage</li> <li>(b) Functioning of the electric circuits</li> <li>(c) Functioning of the hydraulic circuits</li> <li>(d) Motor protection from overload</li> <li>(e) Checking current draw with ammeter</li> </ul>
3. Checking circuits for power actuated seats and components	<ul> <li>(a) Components of power seat mechanism: motor, switch, relay, jack screws, linkage</li> <li>(b) Circuits controlling the fore and aft motion of the seat</li> <li>(c) Circuits controlling the up and down motion of the seat</li> <li>(d) Arrangement of the seat runners</li> <li>(e) Checking current draw with ammeter</li> </ul>
4. Trouble finding	<ul> <li>(a) Causes of motor overheating</li> <li>(b) Causes of sluggish operation</li> <li>(c) Voltage drop caused by parasitic resistance</li> <li>(d) Nature of relay and switch troubles</li> </ul>

BLOCK 26: Engines: Accessories and Components - Cooling System

## TABLE OF CONTENTS

# Block Twenty-Six - One Unit

peration	ge
1: Draining, flushing and filling cooling system 9	)2
2: Removing and replacing hose connections 9	12
3: Removing and replacing thermostat 9	2
4: Removing and replacing radiator 9	)2
5: Removing and replacing water distribution	
tube 9	2
6: Removing and replacing expansion plug 9	2
7: Removing and replacing fan assembly 9	13
8: Removing, reconditioning and replacing	
water pump	13
	13
	13

BLOCK 26: Cooling System

UNIT 1: Servicing Procedures

OPERATIONS	KNOWLEDGE
1. Draining, flushing and filling cooling system	<ul> <li>(a) Location of drain cocks</li> <li>(b) Effect of cold liquid on hot metal</li> <li>(c) Filling levels</li> <li>(d) Air locks</li> <li>(e) Advantages of normal operating temperatures</li> <li>(f) How to connect and properly use pressure gun</li> <li>(g) Types and value of flushing solutions</li> </ul>
2. Removing and replacing hose connections	<ul> <li>(a) Hose clamps - types and locations</li> <li>(b) Moulded and straight hose</li> <li>(c) Troubles occurring with hose connections and hoses</li> </ul>
3. Removing and replacing a thermostat	<ul> <li>(a) How coolant is circulated</li> <li>(b) Types and operation of thermostats</li> <li>(c) How to test a thermostat</li> <li>(d) Thermostat by-passes and why used</li> <li>(e) Thermostat troubles</li> </ul>
4. Removing and replacing radiators	<ul> <li>(a) Types and construction of radiators</li> <li>(b) Radiator pressure caps, purpose and how to test</li> <li>(c) Troubles occurring with radiators and how to repair (excepting core leaks)</li> </ul>
5. Removing and replacing water- distributing tube	<ul> <li>(a) How heat is transmitted</li> <li>(b) The effect of an improperly installed water-distributing tube</li> <li>(c) The effect of foreign deposits in the passageways</li> </ul>
6. Removing and replacing expansion plug	(a) What holds the plug in position (b) Precautions necessary

BLOCK 26: Cooling System

UNIT 1: Servicing Procedures

OPERATIONS	KNO WLEDGE
7. Removing and replacing fan assembly	(a) Types of fan assemblies (b) Fan belt adjustment; precautions
8. Removing, reconditioning and replacing water pump	<ul> <li>(a) Pump construction: housing, bearings, seals, gaskets</li> <li>(b) Method of dismantling, repairing and assembling water pump</li> <li>(c) Reasons for pump failure</li> </ul>
9. Winterizing by use of anti- freeze	<ul> <li>(a) Types of antifreeze and their characteristics</li> <li>(b) Specifications: volume of cooling system, amount of antifreeze required to safeguard the cooling system</li> <li>(c) Rust inhibiters</li> <li>(d) Use of antifreeze testers</li> <li>(e) Effect of temperatures on hydrometer readings</li> <li>(f) Science: density</li> </ul>
10. Checking cooling system	<ul> <li>(a) Cause of cooling system leaks</li> <li>(b) How to locate external and also internal engine leaks</li> <li>(c) How to make necessary repairs</li> </ul>

# BLOCK 27: Engines: Accessories and Components - Maintenance Techniques TABLE OF CONTENTS UNIT 1: Basic Information ..... Page 96 Principle of the internal combustion engine, the purpose and function of various components UNIT 2: Oil Pan ..... Page 97 Operation 1: Changing engine oil 2: Removing oil pan 3: Checking oil pan (removed) 4: Replacing oil pan UNIT 3: Cylinder Head ..... Page 98 Operation 1: Removing cylinder head 2: Cleaning and checking head 3: Replacing cylinder head UNIT 4: Valves and Valve Operating Mechanism ..... Page 99 Operation 1: Removing and replacing engine valves 2: Cleaning, checking and refacing engine valves 3: Cleaning, checking and if necessary replacing valve guides 4: Removing, checking and replacing valve springs 5: Removing, checking, repairing and replacing valve lifters 6: Reconditioning rocker arms and shafts 7: Removing and replacing valve timing cover 8: Replacing oil seal in timing cover 9: Removing and replacing camshaft drive gears and chain 10: Removing and checking camshaft 11: Checking camshaft bearing and replacing if necessary 12: Reconditioning valve seats 13: Replacing valve seats 14: Adjusting tappets

BLOCK 27: Engines: Accessories and Components - Maintenance Techniques TABLE OF CONTENTS Crankshaft, Main Bearings, Connecting Rod Bearings, Flywheel and Vibration Damper ...... Page 102 Operation 1: Cleaning crankshaft 2: Checking truth and size of journals and crankpins 3: Grinding crankshaft 4: Checking the main bearings and replacing as required 5: Checking the connecting rod bearings and replacing as required 6: Replacing rear main bearing seals 7: Removing and replacing flywheel 8: Installing flywheel ring gear 9: Removing and installing crankshaft vibration damper UNIT 6: Connecting Rod, Piston, Piston Rings and Cylinder ..... Page 104 Operation 1: Removing connecting rod and piston 2: Removing rod from piston and replacing 3: Fitting piston pins 4: Aligning connecting rod and piston; reconditioning connecting rods 5: Installing new rings on piston 6: Reconditioning cylinder 7: Reconditioning pistons 8: Installing pistons, rings and rods in cylinder Page 105 UNIT 7: Manifolds ..... Operation 1: Removing and replacing intake and

exhaust manifolds

UNIT 1: Basic Information

This unit lists the general knowledge which the mechanic or apprentice should master so that he may intelligently diagnose troubles occurring in the automobile engine.

- (a) The Four-Stroke Cycle Principle
- (b) The Two-Stroke Cycle Principle
- (c) Modern valve timing and why used
- (d) Trade terms and their meanings:
  Bore, stroke, T.D.C.C., etc.
- (e) Engine types: "I", "V", multiple-cylinder, etc.
- (f) Characteristics of metals and alloys used throughout engine; how they are fabricated
- (g) Purpose and function of the various parts of the engine
- (h) To find, read and understand specifications
- (i) Oil consumption causes and remedies of over consumption
- (j) Oil loss causes and remedies
- (k) Reasons for loss of engine compression and remedies
- (1) Reasons for low and high oil pressure
- (m) Engine knocks how to diagnose
- (n) Engine mountings how to adjust and replace
- (o) Repairs requiring engine removal e.g. damaged journals, broken crankshaft

UNIT 2: Oil Pan

OPERATIONS	KNOWLEDGE
1. Changing engine oil	<ul> <li>(a) Drain plug locations</li> <li>(b) Troubles occurring with drain plugs and how to remedy</li> <li>(c) Amount and type of engine oil to use</li> <li>(d) Necessary precautions in checking oil level</li> <li>(e) Oil characteristics</li> <li>(f) When oil filter cartridge should be changed</li> <li>(g) How to change filter cartridge: by-pass and series filter</li> </ul>
2. Removing oil pan	<ul><li>(a) How to support the engine when necessary to remove engine mounts</li><li>(b) How to remove steering arms and rods if they interfere</li></ul>
3. Checking oil pan after removal	<ul><li>(a) Use of guages and equipment for checking oil lines and troughs</li><li>(b) How to check and straighten the edges of pan.</li><li>(c) Purpose of baffles</li></ul>
4. Installing oil pan	<ul><li>(a) How to fit pan gaskets</li><li>(b) Precautions necessary</li><li>(c) How to replace any supports or steering mechanism which was removed</li></ul>

UNIT 3: Cylinder Head

OPERATIONS	KNOWLEDGE
1. Removing cylinder head	<ul> <li>(a) How to drain cooling system</li> <li>(b) How to remove units attached to head such as - oil filter, ignition coil, horn, etc.</li> <li>(c) How to remove spark plugs</li> <li>(d) Precautions necessary in removing head nuts, bolts and head</li> </ul>
2. Cleaning and checking head	<ul> <li>(a) Use of carbon brushes and scrapers</li> <li>(b) Effects of carbon deposits</li> <li>(c) How to check head for warpage, cracks or damage</li> <li>(d) Resurfacing of head;</li> <li>(i) Why (ii) How much</li> </ul>
3. Replacing cylinder head	<ul> <li>(a) Correct installation of head gasket</li> <li>(b) Precaution when replacing head and retaining nuts or studs</li> <li>(c) Use of torque wrench</li> <li>(d) Interpreting specifications as to correct torque and pattern for tightening heads of various metals</li> <li>(e) How to replace all attached units</li> <li>(f) How to replace spark plugs correctly</li> <li>(g) How to refill cooling system</li> </ul>

UNIT 4: Valves and Valve Operating Mechanism

	rechanism
OPERATIONS	KNOWLEDGE
1. Removing and replacing engine valves	<ul><li>(a) Precautions necessary</li><li>(b) Construction of valve keepers</li><li>(c) How to remove stuck valves</li><li>(d) Valve stem seals</li></ul>
2. Cleaning, checking and refacing engine valves	<ul> <li>(a) Valve face angles</li> <li>(b) Sodium filled valves</li> <li>(c) Amount of safe margin necessary to leave</li> <li>(d) Necessity of cleaning valve thoroughly</li> <li>(e) Effect of valve stem wear and how to check</li> <li>(f) How to use refacing machine</li> </ul>
3. Cleaning, checking and replacing valve guides	<ul> <li>(a) Use of valve guide cleaners</li> <li>(b) Valve guide wear and how to check</li> <li>(c) How to remove guides</li> <li>(d) How to install valve guides</li> <li>(e) Precautions necessary</li> <li>(f) Use of reamers</li> </ul>
4. Removing, checking and replacing valve springs	<ul> <li>(a) Construction of valve spring</li> <li>(b) Why two springs are used on some valves</li> <li>(c) Spring tension tester</li> <li>(d) Effect of weak valve springs</li> <li>(e) Close coils - correct installation</li> <li>(f) Valve spring retainer washers and their difference in construction</li> <li>(g) Anti-rattle springs and their value</li> </ul>
5. Removing, checking, repairing and replacing valve lifters	<ul> <li>(a) Valve lifter wear and the cause of it</li> <li>(b) Operation of hydraulic valve lifters</li> <li>(c) Use of testing equipment for hydraulic lifters</li> <li>(d) Use of refacing machine for refacing valve tappets</li> <li>(e) Precautions necessary when installing</li> </ul>

lifters

UNIT 4: Valves and Valve Operating
Mechanism

## **OPERATIONS** KNOWLEDGE 6. Reconditioning rocker arms (a) Precautions necessary and shafts (b) Procedure for rebushing and fitting rocker arms (c) How to clean out and check rocker arm shafts (d) Difference between exhaust and intake rocker arms (e) Correct installation of rocker arms and shafts 7. Removing and replacing valve (a) Use of pullers timing cover (b) Precautions necessary (c) Use of alignment tools (d) Causes of oil loss around timing cover 8. Replacing oil seal in timing (a) Types of oil seals cover (b) Oil slingers (c) Correct installation of seals (d) Precautions necessary (e) Alignment of timing cover 9. Removing and replacing camshaft (a) Use of pullers drive gears and chain (b) Timing gear markings (c) Chain markings (d) Adjustment of timing chain (e) Composition timing gears (f) Oversize timing gears (g) Causes of chain and gear wear (h) Noise made by worn gears or chain 10. Removing and checking camshaft (a) Precautions necessary (b) Use of micrometers and dial gauges to check wear (c) Effect of cam wear on valve operation (d) Effect of eccentric wear on fuel pump operation (e) Methods used in checking valve timing

UNIT 4: Valves and Valve Operating Mechanism

OPERATIONS	KNOWLEDGE
ll. Checking camshaft bearing and replacing if necessary	<ul> <li>(a) Use of dial guage and micrometer</li> <li>(b) Use of bearing pullers and drivers</li> <li>(c) Line reaming bearing</li> <li>(d) How to check bearing clearance</li> <li>(e) How to check and adjust end play of shaft</li> <li>(f) Cleaning out oil passageways</li> </ul>
12. Reconditioning valve seats	<ul> <li>(a) Use of valve seat refacing machine</li> <li>(b) Valve seat angles and width</li> <li>(c) Importance of clean and good valve guides</li> <li>(d) Types of grinding stones</li> <li>(e) Material used in valve seats</li> <li>(f) Precautions necessary</li> <li>(g) Use of grinding compound for checking seat and face contact</li> </ul>
13. Replacing valve seats	<ul> <li>(a) Expansion and contraction of metals</li> <li>(b) Types of seats: threaded or pressed in</li> <li>(c) Use of valve seat replacing tools and cutters</li> <li>(d) Precautions necessary</li> </ul>
14. Adjusting tappets	<ul> <li>(a) Effect of temperature on tappet clearance</li> <li>(b) Tappet locking devices</li> <li>(c) Use of feeler gauges</li> <li>(d) Required position of piston and proper stroke for setting tappets on a dead engine</li> <li>(e) Necessity of grinding valve stem or face to make adjustment on some models</li> <li>(f) Precautions necessary when adjusting hydraulic type of tappets</li> </ul>

UNIT 5: Crankshaft, Main Bearings, Connecting Rod Bearings, Flywheel and Vibration Damper

## **OPERATIONS** KNOWLEDGE 1. Cleaning crankshaft (a) Oil passage plugs (b) Oil passage holes 2. Checking truth and size of (a) Use of micrometer (b) Use of dial gauge journals and crankpins (c) Necessary checks to make (d) Cause of shaft wear (e) Cast shaft - forged shaft (f) Allowable wear of shaft (g) Balancing: (i) Static (ii) Dynamic (h) Amount of material which may be removed by grinding (i) Possible results if incorrectly done (j) Metalizing and its characteristics 3. Checking main bearings and (a) Main bearing construction replacing (b) Reasons for bearing failure (c) How bearing is locked in position (d) How to remove bearing (e) Line reaming (f) Use of test shims (g) Use of plastigage (h) Bearing sizes obtainable (i) End thrust bearings (j) Oil grooves and passages (k) Use of torque wrench (1) Adjustable type bearing (shims) (m) Bearing crush 4. Checking connecting rod (a) Bonded bearings bearings and replacing (b) Bearing inserts (c) Reasons for bearing failure (d) Checking bearing clearance (e) Insert sizes (f) Connecting rod nut locking devices (g) Use of torque wrench (h) Procedures possible with engine in place: conditions requiring removal of engine

# AN ANALYSIS OF THE MOTOR VEHICLE REPAIR TRADE

BLOCK 27: Engines

UNIT 5: Crankshaft, Main Bearings, Connecting Rod Bearings, Flywheel and Vibration Damper

OPERATIONS	KNOWLEDGE
5. Replacing rear main bearing seals	<ul><li>(a) Causes of oil leaks past rear main bearing seals</li><li>(b) Types of seals used and precautions when installing the various types</li></ul>
6. Removing and replacing fly- wheel	<ul> <li>(a) Procedures and precautions in supporting the engine, removing the transmission, clutch and bell housing</li> <li>(b) Locking devices for flywheel bolts and nuts</li> </ul>
7. Installing flywheel ring gear	<ul><li>(a) Design of the teeth on the gear</li><li>(b) Use of heat to expand gear</li><li>(c) Importance of allowing gear to cool slowly</li></ul>
8. Removing and installing crank- shaft vibration damper	<ul><li>(a) Use of pullers</li><li>(b) Precautions necessary</li><li>(c) How vibration dampers are held in position</li></ul>

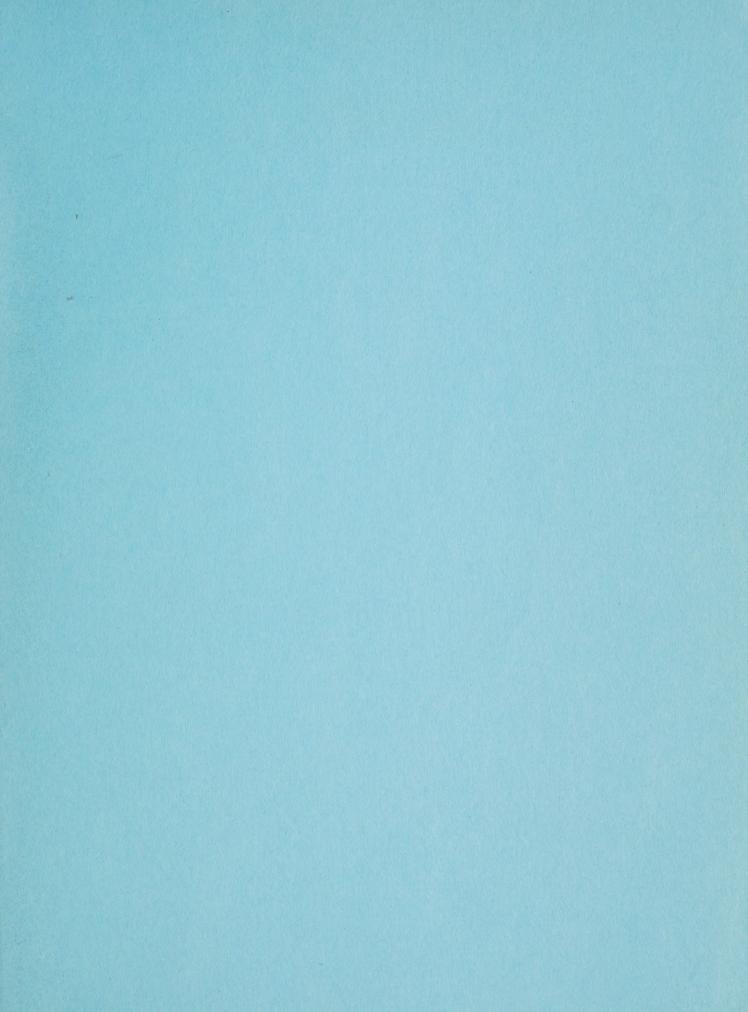
UNIT 6: Connecting Rods, Piston, Piston Rings and Cylinder

OPERATIONS	KNOWLEDGE
1. Removing connecting rod and piston	(a) How to remove cylinder ridge (b) Numbering of pistons and rods
2. Removing rod from piston and replacing	<ul> <li>(a) Piston pin mountings</li> <li>(b) How to remove and install piston pin locks</li> <li>(c) Maximum thrust side of piston</li> </ul>
3. Fitting piston pins	(a) Use of pin hone (b) Use of reamers and broaches
4. Aligning connecting rod and piston	<ul> <li>(a) Use of rod aligners</li> <li>(b) Effects of incorrectly aligned rods and pistons</li> <li>(c) Checking centering of rod between piston bosses in engine</li> </ul>
5. Installing new rings on piston	<ul> <li>(a) Types and purpose of piston rings</li> <li>(b) Recommendations of ring manufacturers for various cylinder conditions</li> <li>(c) How to check ring clearances</li> </ul>
6. Reconditioning cylinder	<ul> <li>(a) Use of micrometers and cylinder gauges</li> <li>(b) How to use cylinder hone</li> <li>(c) Use of cylinder boring bar</li> <li>(d) How to check piston clearances</li> <li>(e) How to deglaze cylinders</li> </ul>
7. Reconditioning pistons	<ul> <li>(a) Knurling of pistons - advantages and disadvantages</li> <li>(b) Regrooving of pistons and the use of spacers</li> <li>(c) Piston expanders and when they should be used</li> </ul>
8. Installing pistons, rings and rods in cylinder	(a) Use of ring compressor (b) Precautions necessary

UNIT 7: Manifolds

heater tubes and valves

# OPERATIONS (a) Correct installation of gaskets and exhaust manifolds (b) How to clean the manifold passageways and the importance of this (c) Dangers of exhaust leaks (d) Effect of intake manifold leaks on engine performance (e) How to check manifold, carburetor,



ALL STREET, SALES